A MODEL OF VOCATIONAL, TECHNICAL AND APPRENTICESHIP CRAFT TRAINING REQUIRED TO MEET THE NEEDS OF THE CONSTRUCTION INDUSTRY IN FLORIDA

By

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KEY TO ABBREVIATIONS

AF of L	American Federation of Labor
AFL-CIO	American Federation of Labor & Congress of Industrial Organizations
BCIAC	Florida Department of Education, Building Construction Industry Advisory Committee
BCTD	Building and Construction Trades Department of the AFL-CIO
BLMI	Florida Department of Labor and Employment Security, Bureau of Labor Market Information
CPLR	Construction Project Labor Requirement
F-BAT	Florida Department of Labor and Employment Security, Bureau of Apprenticeship and Training
F-DOE	Florida Department of Education, Division of Vocational, Adult, and Community Education
FEFP	Florida Education Finance Program
FTE	Full-time equivalent students
RFP	Request for proposal
SAC	State Apprenticeship Council/Agency
US-BAT	United States Department of Labor, Bureau of Apprenticeship and Training
US-DOL	United States Department of Labor

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Construction industry observers have suggested contractors are currently training approximately two-thirds of the industry's annual need for skilled craft workers. The purpose of this study was to test this premise by using Florida as a paradigm, quantifying the actual number of individuals in formal construction craft training programs, and developing a simulation procedure that accurately delineates Florida's annual need for skilled construction craft workers.

The research stratagem at the Florida Departments of Labor and Education identified every registered craft training provider in Florida along with the current enrollment in each program. These craft training providers were subdivided into three groupings: joint apprenticeship programs, nonjoint apprenticeship programs, and vocational and technical education job preparation programs. The entire population of

formal construction craft training providers was surveyed with a 38% overall response rate. The statistical analyses, which use a nonparametric one-way analysis of variance technique, were designed to detect response differences among the three groups of training providers.

A systems dynamics model of the construction craft training process was developed that utilized information derived from the construction craft training provider survey and the Florida Department of Labor's annual industry and occupational employment projections. The model simulation verified that only 16% of the industry's projected annual demand for journeyman-level craft workers (5,750 individuals) was being filled by apprenticeship program completers and 19% of the yearly demand was being filled by semi-skilled vocational and technical education job preparation program graduates. The results of the model simulation verified that the annual number of apprenticeship completers was scarcely sufficient to fill either the number of departures or the expected growth of the foreman-level craft worker labor pool and that the annual number of semi-skilled job preparation graduates was explicitly incapable of filling either the projected number of departures or the expected growth of the journeyman-level craft worker labor pool. This investigation confirmed that Florida's construction industry is providing the craft work force with insufficient formal training opportunities.

Additional analyses of the research data resulted in conclusions and recommendations that will help the construction industry improve the craft training process.

CHAPTER I
INTRODUCTION

Construction craft training has been a contentious issue between contractors and the craft work force for more than a century. In 1888, the National Association of Builders advocated replacing formal apprenticeship training programs with school-based vocational training since, the association believed, apprenticeship training was not able to meet the "modern conditions" the industry was facing at the time (Haber, 1930). Even though contractor organizations were successful in establishing school-based vocational craft training programs, individual contractors showed little interest and were either unwilling or unable to train new workers (Haber, 1930).

The study of construction craft training indicates that, historically, contractors who provide training have been interested only in providing minimum levels of training, while craft trade organizations have fought for broad-based craft training. Due primarily to the cyclical nature of the industry, broad-based training has been advocated as a means to provide multiple employment opportunities for the craft worker. The goal of craft training, according to the trade organizations, is not to provide the craft worker with such narrowly defined skills that he/she is unable to find local employment once a project has been completed, but to provide continued industry employment opportunities.

All the blame for providing inadequate levels of construction craft training cannot be shouldered solely by the contractors. It is difficult to convince a newly hired employee to spend 6 to 10 hours per week in school, typically during evening hours, while also completing a 40-hour work week. World Bank estimates indicate that individuals who have completed formal vocational and apprenticeship training programs earn approximately 50% more over their lifetimes than individuals who have not completed a formal training program (Metcalf, 1985). This suggests there is a positive association between formal construction industry training and craft worker lifetime earnings. Contractors are, however, in the preeminent position to provide both the incentive and the motivation for craft work force participation in training programs by promulgating the benefits of formal craft training.

Statement of the Problem

The construction industry currently faces a shortage of skilled craft workers. This scarcity of skilled workers is projected to increase through the end of the 20th century and continue into the 21st century. A potential solution to this problem is for the construction industry to expand the craft training opportunities available to the work force while increasing retention efforts targeted at journeyman-level workers.

The United States Department of Labor, Bureau of Apprenticeship and Training (US-BAT), under the guidelines set forth in the National Apprenticeship Act of 1937 (29 U.S.C. 50) and the Labor Standards for the Registration of Apprenticeship Programs (29 CFR 29), provides apprenticeship standards for 35 occupational titles in the 20 different trade classifications within the industry (Bureau of Apprenticeship and

Training, 1991). The US-BAT apprenticeship standards for each of the various construction trades address a distinct level of intellectual understanding and manipulative skill ability. The US-BAT has translated these requirements into a different mix of school-based and job-site training for each occupational title. The primary problem, therefore, is not the structure of the training program but the quantity of training currently provided. The fundamental question the construction industry must answer is how many craft workers the industry must train to meet its future labor requirements.

Objectives of the Study

Currently no objective method exists to determine the appropriate levels of construction craft training. Construction craft unions base the annual number of individuals admitted into apprenticeship training programs on member unemployment levels, while contractors base training decisions on perceived costs; neither method addresses the labor needs of the industry. Therefore, the primary objectives of this study were to use Florida as the paradigm to

1. Document the current level of construction craft training in registered apprenticeship programs;
2. Determine the current level of construction craft training in postsecondary vocational and technical education job preparation programs (vo-tech job prep);
3. Determine the current statewide construction craft employment projections, both expected separations and projected growth;

4. Develop a construction labor operations research simulation model utilizing projected construction industry labor requirements and current craft training levels;
5. Develop cost analyses of the construction industry training process; and
6. Make recommendations to improve Florida's construction craft training process.

The purpose of this study was *not* to make comparisons about quality variations between the joint (union) and nonjoint (nonunion) apprenticeship programs, but rather to quantify the current levels of both apprenticeship and job prep training currently being carried out by the industry. The main objective of this study was to determine current levels of construction craft training and utilize the operations research model and its computer simulation to estimate the number of craft workers supplying the demand for skilled (journeyman- and foreman-level) craft workers who receive no formal craft training.

Central Hypothesis

The premise of this study was that the construction industry is not providing enough craft training to meet the industry's demand for skilled craft workers. If this insignificant level of craft training continues, the industry will undergo a significant craft worker skill loss over the next decade. If the current level of formal craft training and its associated costs are determined and analyzed, cost projections can be developed. A central component of this thesis was to approximate the funding commitment required from the construction industry to provide a training level that

meets 80% of the construction industry's projected labor demand for skilled craft workers.

CHAPTER II
REVIEW OF THE LITERATURE

There is a growing belief in the industry that the quantity of construction craft training does not meet the needs of the industry (Fox, 1988; Gasperow, 1990). Industry observers have long realized that craft training is vitally important to the construction industry since training levels directly influence cost, productivity, quality and safety (Weinberg, 1969; Liska, 1994). Three basic methods of providing construction industry training: (1) formal and informal on-the-job training; (2) training off the job in schools and/or training centers; and (3) formal apprenticeship with academic vocational instruction and structured, supervised, on-the-job training. An investigation into current nationwide levels of construction craft training suggests that approximately 19% of craft workers report receiving formal company training, 38% report receiving informal on-the-job training (of these individuals, approximately 10% also report receiving postsecondary, school-based training), 4% report receiving "other" training and 39% report receiving no craft training at all (Bureau of Labor Statistics, 1992).

Contractors in the industry increasingly recognize that technological change demands continuing education and training for journeyman-level craft workers; however, only 25% of all craft workers report receiving skill improvement training (Bureau of Labor Statistics, 1992). Improving access to, and availability of, craft training is vital in the effort to provide the construction industry with a craft work

force that has a wide range of job skills and is able to adapt to the constantly changing conditions encountered on a construction job site.

Construction Craft Training Overview

The Mission of Construction Craft Training Programs

Formal craft training, specifically formal craft apprenticeship and to a lesser degree vocational and technical education job preparation programs, in the construction industry is designed to produce a skilled, journeyman-level craft worker who can perform a broad range of tasks, including the fundamentals of the craft and all specialized tasks, largely without direct supervision (Mills, 1972). An examination of the relative merits of academic vocational training coupled with a structured on-the-job training program versus a strictly academic vocational training program indicates that a mixture of on-the-job training and academic classroom training is the most effective method of training semiskilled and skilled craft workers (Franklin, 1973). Experience on previous construction sites combined with task evaluation and layout skills are essential for qualified, journeyman-level craft workers (Mills, 1972). Every viable construction industry craft training program must include a combination of formal, structured, on-the-job training coupled with appropriate vocational schooling (Rubens and Harrisson, 1980).

Perhaps the primary function of legitimate vocational, technical and apprenticeship training programs is to develop the craft work force for the construction industry (Foster, 1973). These formal training programs are expected to expose the apprentice to a variety of work and training, both on the job and in the classroom. In

the ideal setting, on-the-job training refers to a systematic process that includes incremental exposure to the diverse elements of the trade; repeated performance of tasks under the direction of a qualified, journeyman-level craft worker; and periodic appraisal of skill development (Franklin, 1973). The training functions of formal programs are not designed to produce semiskilled laborers, but rather a core of broadly skilled craft workers whose skill mastery gives them the distinguished "journeyman-level craft worker" status (Mills, 1972).

Formal training is offered to few young persons entering the construction industry due to the inadequacy of training mechanisms. Many "journeyman-level" craft workers in the construction industry become so without ever obtaining formal instruction. The failure of formal training programs to produce the appropriate number of craft workers can be attributed to a failure of both the planning process and to political opposition from trade unions (Mills, 1972). The problems with formal vocational, technical and apprenticeship programs, along with the solutions, lie within the construction industry itself.

Labor Relations in the Building Trades

The American Federation of Labor (AF of L) issued the formal charter of the Building and Construction Trades Department on March 20, 1908, to the seven founding member unions: Carpenters, Iron Workers, Lathers, Painters, Plumbers, Steam Engineers and Tile Layers (AFL-CIO, 1983). By 1917, membership in construction trades unions constituted more than one-fifth of the entire membership of the AF of L (AFL-CIO, 1983). These early years were marked with interunion

jurisdictional disputes in the unions' struggle for control of the work. During the early 1920s, approximately 95% of all strikes were disputes among trade unions protecting their "trade jurisdiction" from infringement by other unions rather than protecting working conditions and standards from attack by employers (Haber, 1930). Employers often attempted to substitute workers of a lower wage union for workers of a higher wage union, which exacerbated this problem (Haber, 1930).

As these early trade unions became more powerful, they began to introduce work rules and establish restrictions on output. These work rules were created either by the unions or the employers, or arrived at jointly, depending upon the nature of the activity controlled by the work rules and the relative bargaining strength of the parties (Haber, 1930). Employers tended to view many of the restrictive union regulations as faulty economic policy; however, the regulations were appropriate policy from the point of view of perpetuating the union and protecting the living standards of the membership (Haber, 1930). Many construction employers were less opposed to recognizing collective bargaining agreements than they were to acquiescing to the regulations the unions enacted in their efforts to protect wages, hours and working conditions (Haber, 1930).

The employer-employee relationship in the construction industry began to change during World War II. The war effort created an urgent need for rapidly designed and built defense projects. Many of these large projects were constructed by nationally oriented design-build contractors who had large in-house engineering staffs (Edmister, 1991). When these large, typically unionized contractors entered a local labor market, local union leaders tended to keep a close watch on work assignments

and job conditions and, at times, took positions on jurisdictional issues that most observers regarded as extreme or unwise (Mills, 1972). At times of full employment and favorable market conditions, the unions tended to steadfastly enforce work rules, especially on large construction projects (Haber, 1930).

After World War II, many business leaders thought the trade unions were becoming too powerful (Edmister, 1991). Congress passed the Labor Management Relations Act of 1947 (Taft-Hartley Act), partially in response to these perceptions (Zieger, 1986). Although President Harry Truman initially vetoed the Taft-Hartley Act, Congress overrode the veto in 1947 (AFL-CIO, 1983).

The Taft-Hartley Act outlined union unfair labor practices and also permitted the states to outlaw the closed-union-shop. The following 21 states currently have "right-to-work" laws that legislatively prohibit the closed-union shop (Gall, 1988):

State	Year Legislation Passed
Alabama	1953
Arizona	1947
Arkansas	1947
Florida	1943
Georgia	1947
Iowa	1947
Kansas	1957
Louisiana	1954 & 1976
Mississippi	1954
Nebraska	1947
Nevada	1951
New Mexico	1947
North Carolina	1947
North Dakota	1947
South Carolina	1954
South Dakota	1947
Tennessee	1947
Texas	1947
Utah	1955

State	Year Legislation Passed
Virginia	1947
Wyoming	1963

The right-to-work laws in these states encouraged the growth of nonunion construction firms within the state borders. With very few exceptions, these nonunion contractors were initially small firms, competing in local construction markets, with each firm having less than $1 million in annual billings (AFL-CIO, 1983).

Congress passed the Labor-Management Reporting and Disclosure Act of 1959 (Landrum-Griffin Act), which allowed union hiring halls to refer members based on seniority, residence, and experience--an exclusive referral system (Perloff, 1981). The Landrum-Griffin Act also authorized collection of training funds and joint administration of union-management training programs (Mills, 1972). This last provision became the cornerstone of the union apprenticeship training programs by providing the mechanism to collect apprenticeship training funds, treated as trust funds, from unionized employers. Training funds, which are primarily collected through a levy attached to the journeyman wage rate, are jointly administered by the apprenticeship training committee (Mills, 1972).

Between 1957 and 1962, unemployment in the unionized construction industry was never less than 12% (Perloff, 1981). By 1965, however, union construction unemployment fell to approximately 4% (Perloff, 1981). This low unemployment level was partially responsible for dynamic changes in the construction industry. In certain geographical areas, without fear of outside competition from nonunion firms, construction labor unions were able to gain control over the labor supply and introduce

inflexible and restrictive work practices, demand and receive higher wages, and enact greater restraints on contractor management (Haber, 1930; Edmister, 1991). Many union business agents began to advocate unreasonable positions on local labor issues while threatening to withhold the services of the union craft worker--a powerful weapon (Borcherding, 1976; Edmister, 1991). Fragmented contractor management associations, which collectively bargained with the trade unions, agreed to union demands rather than face disruptive strikes (Haber, 1930; Edmister, 1991). The driving force behind the escalating wage increases can be attributed to the contour wage theory that postulates local unions were engaged in wage rate leapfrogging during this period (Schulenburger, 1978). In heavily organized areas of the country, local unionized contractors had no incentive to contest unions' demands for higher wages (Maloney, 1978; Edmister, 1991). Each contractor would have the same base labor cost, effectively taking labor out of market competition, and these increased labor costs would be passed on to the owner.

Between 1967 and 1974 the construction unions were able to collectively bargain for an average 64.2% wage increase (Perloff, 1981). As construction labor costs began to adversely affect the cost of new facilities, the users of construction services began to organize. The Construction Users Anti-Inflation Roundtable was founded in 1969 and later renamed and combined with other alliances in 1972 to form the Business Roundtable (1983). This organization of chief executives of the nation's largest industrial corporations began to focus on labor costs as a method to reduce construction costs of new facilities. As these owners became aware of the actual costs of restrictive union labor practices and craft jurisdictional disputes, the owners,

particularly in the South, began to experiment with nonunion construction companies during the early 1970s (Allen, 1988). During the late 1970s and early 1980s, the Business Roundtable's Construction Industry Cost Effectiveness Project produced 23 individual reports on specific construction industry problem areas (Business Roundtable, 1983). The summary report identified 57 inefficient work restrictions not required by collective bargaining agreements that inflated union labor costs by an estimated 15% (Business Roundtable, 1983).

The construction industry historically has been one of the largest industries in the United States, contributing anywhere from 4% to 5% of the nation's Gross National Product for any given year (United States Bureau of the Census, 1993). Construction industry spending increased from $91.3 billion in 1970 to approximately $400 billion by 1987 (United States Bureau of the Census, 1993). By the late 1970s the average nonunion general contractor, paying two-thirds the union wage rate for labor, had a 6%-7% cost advantage over the unionized general contractor (Diekmann and Peppler, 1984). By 1984, nonunion contractors accounted for more than 70% of the construction dollar volume (Northrup, 1985). The nonunion share of the construction industry market has continued to increase slowly and was approximately 80% of the labor pool by 1993 (Tomsho, 1993). The decline in unionized construction is further evidenced by employment information compiled by the United States Department of Labor, Bureau of Labor Statistics. In 1973, the Building and Construction Trades Department (BCTD) of the American Federation of Labor-Congress of Industrial Organizations (AFL-CIO) represented 40% (1,722,000) of the

4.3 million construction workers; by 1987, the BCTD represented only 22% (1,123,000) of the more than 5 million construction workers.

Construction Craft Apprenticeship Training

The origins of construction industry craft training in the United States date to the British system of trade union structure with its tradition of private sponsorship and funding (Motley, 1907). Throughout the 19^{th} century and continuing until World War I, the construction industry relied on European immigrants for skilled craft labor. In 1888, the National Association of Builders advocated replacing formal apprenticeship training programs with school-based vocational training since, the association believed, apprenticeship training did not meet the "modern conditions" the industry was facing at the time (Haber, 1930). Although contractor organizations at the time were successful in establishing school-based vocational craft training programs, individual contractors showed little interest and were unwilling and/or unable to train new workers (Haber, 1930).

By 1928, construction craft apprenticeship training efforts were still haphazard, employer-sponsored, on-the-job training programs without uniform national standards (Haber and Levinson, 1956). These 1920s-era apprenticeship programs were used by both employers and early labor unions as one, and perhaps the primary, method of regulating the number of new workers entering the industry (Franklin, 1973). During the 1930s, when thousands of skilled craft workers were unemployed, union resistance to apprenticeship training programs was intense, and employers were unwilling to assume the costs and obligations of craft training at a time when skilled workers were

readily available (Haber and Levinson, 1956). For these reasons, construction craft training became and has continued to be a contentious issue between employers and the construction craft work force.

The only apprenticeship legislation that has been promulgated at the federal level was the passage of the National Apprenticeship Act (Fitzgerald Act) in 1937. In 1911, Wisconsin became the first state to adopt an apprenticeship statute (Glover, 1986). The Smith-Hughes Act of 1917, which established the legislative origins of vocational education in the United States, was initially intended as a replacement for formal craft apprenticeship (Haber, 1930; Hamilton, 1990). The Fitzgerald Act, which established a uniform federal apprenticeship policy for the United States (29 U.S.C. 50 §1), required the Secretary of Labor to establish standards for apprenticeship training and provided neither encouragement nor incentive for states to get involved in apprenticeship training (Haber and Levinson, 1956).

Pursuant to the Fitzgerald Act, the United States Department of Labor (US-DOL) established guidelines for apprenticeship training that forced the formalization of training policies in each of the construction crafts. The original national apprenticeship standards were established by national joint apprenticeship committees for each of the building trades, with each committee composed of an equal number of members from the individual BCTD unions and respective national employer associations (United States Department of Labor, 1938). Consequently, the BCTD was the first construction organization to establish formalized apprenticeship training programs for the building trades that followed the US-DOL guidelines (Levitt, 1979).

The requirements were promulgated by the US-DOL, but administration and control of the programs were kept at the local level (Haber and Levinson, 1956).

"Labor Standards for the Regulation of Apprenticeship Programs," published in the Code of Federal Regulations, established the minimum standards for sponsors of apprenticeship programs (29, CFR 29.5). Following is a summary of the minimum apprenticeship standards:

1. Initiation of a written apprenticeship agreement
2. Minimum starting age of 16 years
3. Written schedule of work processes the apprentice will learn on the job
4. Minimum of 144 hours per year of organized technical instruction
5. Progressively increasing wage schedule
6. Supervision of on-the-job training and adequate training facilities
7. Periodic review and evaluation of the apprentice's progress, both on the job and in the classroom
8. Cooperation by both employers and employee organizations
9. Recognition of successful completion of the apprenticeship program
10. Training without regard to race, creed or national origin

In the United States high school graduates historically have displayed little interest in apprenticeship or skilled blue-collar jobs (Rubens and Harrisson, 1980). The educational system and faulty school-to-work transition programs play an important role in this negative attitude (Hamilton, 1990). The United States and Canada are the only two industrialized nations in the world where apprenticeship is not a teenage youth training program (Rubens and Harrisson, 1980). In most countries (Germany, Great Britain, Australia and Japan, for example) apprenticeship is a teenage youth employment program. This is not true in the United States, where the construction trades apprentice is older, has more years of general education, is enrolled

for a longer apprenticeship training period, receives less on-the-job supervision, has fewer hours of off-the-job training and has a higher dropout rate (Rubens and Harrisson, 1980; Glover, 1986).

The United States is the only country investigated that has not established training councils or industry training boards for apprenticeship training. Thirty-two states do not a have State Apprenticeship Council (SAC), thus making the United States the only industrialized country that relies on an incomplete federal-state system of apprenticeship administration (Glover, 1986). The 28 states and 3 territories that do have an SAC are Arizona, California, Connecticut, Washington, D.C., Delaware, Florida, Hawaii, Kansas, Kentucky, Louisiana, Guam, Maine, Maryland, Massachusetts, Minnesota, Montana, Nevada, New Hampshire, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Puerto Rico, Rhode Island, Vermont, Virgin Islands, Virginia, Washington and Wisconsin (Bureau of Apprenticeship and Training, 1991). Many of these states, facing budgetary shortfalls, are reducing or eliminating SAC funding levels. The Florida legislature has ever eliminated funding for the Florida Bureau of Apprenticeship and Training.

There also is a serious problem associated with the secondary educational system that until recently has been focused entirely on presenting college preparation course work at the expense of those students who do not attend college. Middle schools and high schools have actively moved away from "industrial arts" class offerings, and career counselors have not effectively promoted the construction industry to students who are not college bound (Federle, Rowings, and DeVany, 1993). The construction industry's characteristic of undertraining the work force devalues the

work done by all workers, especially the most highly skilled craft workers, and leaves most of the work force with few options for upward social mobility, which also prejudices high school career counselors (Hamilton, 1990).

Current Construction Craft Apprenticeship Training Practices

Vocational, technical and apprenticeship training and continuing education programs are expensive to establish and administer (Rubens and Harrisson, 1980). Many employers perceive these training programs as costly propositions that do not pay off, especially when workers are likely to go to work for competitors before employers' training costs can be recovered (Rubens and Harrisson, 1980). Nontraining employers view the employees and/or other employers as ultimately receiving the training benefits (Rubens and Harrisson, 1980).

A conflict of interest exists between the construction employers and the work force regarding scope of training. Because building trades craft training is universal in nature, and not firm specific, it is generally cheaper for a contractor to hire craft workers trained by other firms than it is to actually train craft workers (Rubens and Harrisson, 1980). The BCTD unions have tried to keep apprenticeship training as extensive as possible to ensure job mobility since extent of training and competence of skilled craft workers are strongly related to craftsmen's ability to secure work (Mills, 1972; Franklin, 1973).

The nonunion sector of the construction industry has tried but has not had complete success in enhancing the skills of nonunion construction helpers or "apprentices" (Levitt, 1979). US-BAT has approved national standards for nonunion

apprenticeship training programs; however, nonunion construction firms generally have not been effective in establishing a wide range of vocational and apprenticeship programs (Foster, 1973; United States Department of Labor, 1975). Most nonunion training programs tend to include extensive informal on-the-job training, which typically translates to random observation of others' work (Foster, 1973). At most smaller contractors, the apprentice's time is devoted largely to production work; any training that occurs is largely a by-product (Mills, 1972; Foster, 1973). Essentially, most contractors, both union and nonunion, are not <u>individually</u> equipped to support broad, systematic craft instruction to the untrained or marginally trained work force (Foster, 1973).

The largest nonunion firms have established task or modular training programs to train unskilled workers within very narrow task structures (Northrup, 1985). Upon completing a specific task training module, the worker typically receives a certificate of completion (Northrup, 1985). These modular training programs tend to be job specific so the employer can recoup training costs as soon as possible (Business Roundtable, September, 1982; Northrup, 1985). It is unclear whether these narrowly defined training programs provide employees any advantage in securing future employment.

There is also a movement within the nonunion sector of the construction industry to promote "competency-based" training for the construction crafts (Northrup, 1992). Competency-based apprenticeship training, as proposed for the construction trades, refers to the practical and theoretical instruction integrated into individual learning packages that enables apprentices to proceed at their own pace (Northrup,

1992). Competency-based training programs are required to meet US-DOL standards, under the guidelines set forth in the 1937 Fitzgerald Act, if the program is to be registered with US-BAT. The length of apprenticeships, as established by US-BAT, tends to reflect differences among the various construction trades. These differences require adjustments in the number of hours required for training in each of the various building crafts. It is difficult to reduce the time element of vocational and apprenticeship training without impairing training content (Rubens and Harrisson, 1980). Competency-based apprenticeship and vocational training must not be misused or diminish scope of training.

Since the United States tends to train inadequate numbers of construction industry apprentices, journeymen who have graduated from formal apprenticeship programs work more hours annually than do workers who have not completed a formal apprenticeship program (Franklin, 1973; Glover, 1986). Those individuals who complete apprenticeship training are more likely to maintain employment related to their training and usually suffer fewer and briefer periods of unemployment than narrowly skilled craft workers (Franklin, 1973).

Graduates of formal apprenticeship programs are broadly trained, adaptable to change, likely to undertake continuing education and more likely to stay with the trade (Franklin, 1973). Apprenticeship training program graduates also are more likely to become craft supervisors (Franklin, 1973). In one study, 39% of construction supervisors had completed a formal apprenticeship training program, whereas only 33% of all journeyman-level craft workers had completed a formal training program, indicating that more craft supervisors tended to be apprenticeship graduates (Franklin,

1973). Studies also have shown that workers with formal apprenticeship instruction are more productive than workers with other types of training (Glover, 1986).

Supporters of apprenticeship training claim that underutilization of apprenticeship results in shortages of skilled journeymen that ultimately diminish the quality of the constructed product (Franklin, 1973). Others argue that the primary purpose of formal apprenticeship in the construction industry is to produce a pool of supervisors and key skilled craft workers for any given trade (Northrup, 1985).

Construction Craft Related Vocational and Technical Education

In the United States, apprenticeship is only one way to acquire construction skills. The primary methods of skill acquisition in the construction industry, both formal and informal, are within the construction industry (Foster, 1970). Nonapprenticeship sources of skill acquisition in the construction industry include training in other industries, vocational and technical schools, military training and informal instruction by friends and relatives (Foster, 1970). Informal training in the construction industry also is gained through unstructured skill acquisition such as observation of others' workmanship.

The national shift away from unionized construction and toward nonunion construction has contributed to a restructuring of construction craft training processes. This restructuring has sharply limited traditional apprenticeship and favored vocational education mixed with practical experience (Engineering News-Record, 1992). Assorted local nonunion contractor organizations have developed training programs in the various trades and attempted to implement these programs in local vocational

schools. The community and technical college system has provided facilities and teachers for related instruction for many of these programs.

The public role in construction vocational and apprenticeship training is to provide related instruction in the local public school system (Mills, 1972). The problems with nonunion vocational and apprenticeship programs sponsored in community colleges frequently stem from the schools' inability to conduct courses that suit the precise needs and schedules of apprentices, who come from many firms and multiple trades (Rubens and Harrisson, 1980). Uneconomical small classes and individualized instruction typically are required. These problems have limited the success of the vocational and technical education training process in meeting the needs of the construction industry.

An appraisal of the various trades in the construction industry suggests that crafts requiring fundamental intellectual ability (electrical, mechanical and sheet metal trades) rely on a more comprehensive school-based training program than the manipulative skilled trades (bricklayer, cement mason and equipment operator), where training is more logically provided on the job site. The differing skill level requirements in each of the various crafts in the building trades suggest there are internal cost efficiencies related to types of course offerings and duration of training programs (Metcalf, 1985).

The quality of vocational education and training is highly variable in the building trades and depends on sponsoring organization, location, program orientation and instructor competence (Metcalf, 1985). The highly competitive nature of the construction industry (there are approximately 12,450 active, licensed general

contractors in Florida), where contracts are awarded based on lowest estimated cost, also precludes inclusion of training costs in contractors' bids (Coble, 1992). Inconsistent quality of these craft training programs can be directly tied to inadequate funding and may stem from employer perceptions about the cost effectiveness of vocational and apprenticeship training (Glover, 1986). Therefore, the case can be developed and presented that supports expansion of either the entire or selected parts of the vocational education and training system.

Apprenticeable trades in the construction industry cannot normally be learned exclusively in vocational schools. Vocational and technical education is only the first step in skill development for a journeyman-level craft worker. On-the-job experience is deemed the most important part of the apprenticeship training process (Foster, 1970; Franklin, 1973). Improved vocational schooling, prior to apprenticeship, is viewed as a supplement to the apprenticeship process (Kenny, 1988). There is little likelihood that vocational education, without structured on-the-job training, is capable of producing a fully trained journeyman. The appropriate vocational education roles in apprenticeships are to provide a source of well-prepared applicants for apprenticeship and serve as a resource in providing the related instruction portion of apprenticeship (Kenny, 1988). The role of vocational education is <u>not</u> to be a substitute for apprenticeship (Kenny, 1988).

Extensive use of a narrowly skilled or semiskilled work force requires division of work assignments into simple and repetitive tasks commensurate with the employees' skill levels (Northrup, 1985). These substitute craft workers require close and careful supervision by highly skilled journeymen (Levitt, 1979). The role of the

supervisor becomes critical to the overall progress and quality of the construction project (Diekmann and Peppler, 1984). The supervisor must assume complete control of both planning and sequencing the job and also must handle all tasks outside the normal routine (Levitt, 1979). Technological change and increased mechanization are likely to allow substitution of materials, equipment and semiskilled labor for journeyman skills in the basic trades; however, changing technology demands higher craft worker skill levels in the mechanical and electrical trades. The industry-wide move away from analog control systems to digital instrumentation systems in industrial construction is an example of technological change requiring a more highly skilled craft worker than in the past.

These training issues are not new problems to the construction industry. Prior to World War I, the construction industry depended heavily on overseas immigration as the source of skilled labor (Haber, 1930). The restrictions imposed on immigration after World War I eliminated this source of skilled labor. Since the early 1920s contractors have been responsible for providing training for the craft work force (Haber and Levinson, 1956). The industry increasingly recognizes that strengthening contractor commitment to formalized vocational, technical and apprenticeship training programs and expanding contractor cooperation, especially in the nonunion sector of the industry, is necessary if the construction industry is to provide the training necessary to meet the needs of both contractors and employees (Rosenbaum, 1991; Associated General Contractors, 1991; Liska, 1994).

Sources of Construction Craft Labor Market Information in Florida

In 1943, Florida was the first state in the United States to pass a right-to-work law (Gall, 1988). Its tradition of nonunion construction has led to a wide variety of vocational and apprenticeship training programs. Formal apprenticeship programs are sponsored by individual construction firms, associations of nonunion employers and associations of union employers. Vocational and technical education programs, taught at both secondary and postsecondary institutions, also are available for some crafts.

Florida Department of Labor and Employment Security, Bureau of Apprenticeship and Training

The Florida Department of Labor and Employment Security, Division of Labor, Employment and Training, Bureau of Apprenticeship and Training (F-BAT), compiles the apprenticeship records of registered apprenticeship programs in Florida. These records are kept in hard-copy form in Tallahassee. Each registered apprenticeship program is required to establish an apprenticeship committee whose duties must include the following (Florida Department of Labor and Employment Security, 1990):

1) Screen and select applicants for apprenticeship
2) Maintain all records for at least 5 years
3) Determine credit to be granted (if any) to applicants for previous experience or education, according to policy
4) Enter into apprenticeship agreements between the apprentice and the committee as program sponsor and submit these agreements to the Registration Agency [F-BAT] for registration
5) Maintain a record of each apprentice's training progress on the job and in related classroom instruction
6) Review regular progress reports for apprentices and recommend actions as appropriate
7) Arrange tests for determining the apprentice's progress in manipulative skills and technical knowledge

8) Notify the Registration Agency [F-BAT] of all other apprentice actions including registrations, reinstatements, cancellations and repeat periods
9) Notify the Registration Agency [F-BAT] when apprentices have satisfactorily completed their apprenticeship and request issuance of a Certificate of Completion to such apprentices
10) Provide for continuous employment of apprentices insofar as possible
11) Secure, if possible, Participating Employer agreements for designated employers and notify the Registration Agency [F-BAT] by copy
12) Hear and adjust complaints of violations and make rulings as deemed necessary
13) Recommend such changes in the program as deemed necessary to improve effectiveness and efficiency
14) Notify the Registration Agency's [F-BAT] representative of all apprenticeship committee meetings and make available, upon request, official meeting minutes
15) Provide apprenticeship records for review, upon official request of the Bureau's servicing representative
16) In general, be responsible for the successful operation of the program and the welfare of the apprentices by performing the duties listed herein

These apprenticeship committee regulations were promulgated under the guidelines established by US-BAT (Florida Statutes, Chapter 38c-16 §1-§10).

Florida Department of Labor and Employment Security,
Bureau of Labor Market Information

The Florida Department of Labor and Employment Security, Division of Labor, Employment and Training, Bureau of Labor Market Information (BLMI), annually compiles and forecasts industry and occupational employment projections. The BLMI uses 14 different statistical analysis techniques, 7 shift and share models and 7 regression models to simulate individual occupational projections, with each model using both historical and current employer-provided data. The statistical model with

the best fitting R^2, Durbin-Watson statistic, or t-statistic for each of the individual employment codes is chosen for inclusion in the general employment model.

The BLMI projects construction industry employment rising from 323,278 workers in 1990 to 390,154 workers by the year 2005 (Florida Department of Labor and Employment Security, 1992)--an increase in employment of 66,876 workers or 20.69%. These employment figures are broken down into "General Building Contractors," "General Contractors except Building" and "Special Trade Contractors" as well as by craft. The BLMI also predicts the number of yearly openings for each craft. If each of Florida's registered apprenticeship programs and vocational education programs were to train for all the projected openings (growth plus separations)--approximately 11,934 individuals per year--vocational and apprenticeship training for the building trades in Florida would be a significant undertaking.

Florida Department of Education, Division of Vocational, Adult and Community Education

The Florida Department of Education, Division of Vocational, Adult and Community Education (F-DOE), compiles the number of students enrolled in vocational and technical education job preparation training programs (vo-tech job prep). The Florida Department of Education, Division of Public Schools, provides funding to local school districts based upon the 1973 Florida Education Finance Program law. Funding calculation is based on number of full-time equivalent students (FTE) (Florida Department of Education, 1993).

System Dynamics Modeling and Simulation

The system dynamics (sometimes referred to as industrial dynamics) approach to model building is a method of interpreting a simplified representation of interacting components that work together for some purpose (Richardson and Pugh, 1981). For construction craft training, these elements would include joint apprenticeship training programs, nonjoint apprenticeship training programs, vo-tech job prep programs and informal on-the-job training combined with job-site requirements for construction craft labor and expected craft labor market activity.

The following seven basic components must be addressed when using a system dynamics strategy for problem solving (Richardson and Pugh, 1981; Roberts, 1983):

1) Problem identification and definition
2) System conceptualization
3) Model formulation
4) Analysis of model behavior
5) Model evaluation
6) Policy analysis
7) Model use or implementation

These components form the foundation for developing a fundamental understanding of any complex process--in this case, the construction craft training procedure.

The system dynamics theory was originally developed by the Massachusetts Institute of Technology, School of Industrial Management (now the Alfred P. Sloan School of Management), as a methodology for designing and/or reorganizing corporate organizational policy (Roberts, 1978). This approach ties the segmented functional features of formal organizations into an integrated model of varying rates of flow and responsively changing levels of accumulation. In the model development process, decisions are viewed as controllers and represented as control valves (Richardson and

Pugh, 1981). These decisions are represented by mathematical equations, based in part on information about the initial contents of the source level, and control the rate of flow to the destination level (Roberts, 1983). The equations, mathematical descriptions of the operations of the system being simulated, represent either implicit or explicit procedures developed for the system operations (Roberts, 1978). By quantifying the current behavior of the construction craft training process, projections of the consequences of continuing the current magnitude of craft training can be constructed.

If the system dynamics modeling technique were to be used on the construction craft training process, a conceptual, prototype paradigm that delineated current construction industry processes of craft skill development could be produced. This computer simulation of the model would be designed as a flexible tool to quantify the craft training process and eliminate informal subjective preconceptions about craft training. The final operating model could be used by policy makers to supplement construction craft training decisions and to determine consequences of maintaining current construction craft training policies.

CHAPTER III
METHODOLOGY

The fundamental purpose of this research was to develop an operations research simulation model of the construction industry's craft labor training process. Complementing the contractor's training decision with an objective procedure, one that takes the subjective bias out of the training decision, could increase the construction industry's commitment to craft training.

Of primary importance to this model development was information quantifying current enrollment levels in both joint and nonjoint apprenticeship training programs and in the publicly funded vo-tech job prep programs. This information was collected by the Florida Departments of Labor and Education and provided to the researcher.

Also of crucial influence on the model was the projected dropout rate associated with each of the three training programs. This information was discovered through a survey instrument distributed to training providers throughout Florida.

Identifying projected demand for construction craft labor was also a critical portion of the craft training model simulation development process. The BLMI performs regression analyses on historical and current employment databases to project future labor requirements for the state.

Once the data were collected and compiled, the simulation model was constructed and tested. Results of model simulation were used to support recommendations and defend conclusions.

Cost analyses were developed using data provided by F-DOE. These cost analyses were used to identify the magnitude of funding provided to support construction craft training.

Finally, a follow-up questionnaire was developed and sent to respondents of the primary survey instrument. This questionnaire was created to test respondents' reactions to proposed recommendations.

Sample Selection

Florida Bureau of Apprenticeship Data

Florida is one of 31 states or territories that have a State Apprenticeship Council/Agency (SAC). Apprenticeship records for the state are kept at the F-BAT office in Tallahassee; however, copies also are kept in the US-BAT state office, also located in Tallahassee. Florida operates under a Sunshine in Government Law that opens most state agency records to the public for review. To gain access to the US-BAT records, the researcher would have to sue under the Freedom of Information Act, a convoluted and lengthy process. Upon a request from the researcher, F-BAT supplied a dated list of all registered apprenticeship training providers in Florida. F-BAT does not, however, summarize apprenticeship records or keep running totals of the number of apprentices enrolled in each of the registered training programs. Apprenticeship records are kept in hard-copy form at the F-BAT office and are not

computerized. Therefore, the researcher made a formal, written request access to the F-BAT paper records. Formal approval for access to the Florida Department of Labor and Employment Security, Division of Labor, Employment and Training, Bureau of Job Training, apprenticeship records was granted in June 1993. The researcher manually searched the paper records to determine

1. The number of registered apprentices in each program,
2. The number of registered programs currently inactive and
3. Any programs that were not identified in the original listing.

As of December 1992, there were 58 joint apprenticeship training providers offering 83 craft training programs with an enrollment of 1,795 apprentices, and 39 nonjoint apprenticeship training providers offering 92 craft training programs with an enrollment of 1,671 apprentices. The updated list of training providers was used as part of the database for the survey instrument; the number of joint and nonjoint registered apprentices was used in the simulation model.

Florida Department of Education Data

The F-DOE provided, upon request, a listing of all construction-related course work taught in publicly funded secondary and postsecondary educational institutions. The F-DOE data identified 64 postsecondary vo-tech job prep training providers offering 185 construction-related programs with 5,095 enrolled students. Identification of the postsecondary vo-tech job prep training providers completed the final portion of the database for the survey instrument, and enrollment data were used in the simulation model. The F-DOE data also identified 81 apprenticeship training programs with 3,179 enrolled students, and 114 supplemental (typically continuing

education) training programs with 4,526 enrolled students, who were taught and funded through vo-tech programs. This information was used in the cost analyses.

Projected Construction Labor Demand

The BLMI employment calculation methodology, which is performed under annual grants from the U.S. Department of Commerce, Bureau of the Census, is uniform throughout the United States. The *Florida Industry and Occupational Employment Projections 1990-2005* handbook identifies 40 individual construction-craft-related occupations. The handbook summarizes construction employment by Occupation Code and Industry Code. The researcher used the BLMI summary Occupation Code 87000000, "Construction Trades & Extractive Occupations," number rather than the employment calculations for each of the individual craft occupations or the Industry Code figures, although either of these methods would have been acceptable.

Primary Survey Instrument Design

In January 1993, the researcher was awarded a research contract from the Florida Department of Education, Building Construction Industry Advisory Committee (BCIAC), under the title "Recommended Changes to the Existing Vocational/Continuing Education Programs for the Building Trades." The request for proposal (RFP) was specific and enumerated 31 research questions to be answered, 20 of which were applicable to construction industry training providers (joint and nonjoint apprenticeship programs and vo-tech job prep programs). Additional questions that

facilitated and supported the operations research model for this treatise were developed and included.

The survey instrument (see Appendix A) was developed utilizing "The Total Design Method" (Dillman, 1978). Open-ended questions were developed to allow respondents to describe their biggest problems and suggest improvements for the training process. Closed-ended questions with ordered choices were developed to distinguish opinion differences among the three groups of training providers. Partially closed-ended questions were developed to identify numerical cost and enrollment differences among the three groups of training providers.

Primary Survey Instrument Testing

The preliminary survey instrument was developed and reviewed by the BCIAC project coordinator. Once changes were made to the survey instrument, a list of candidates was developed who would test the preliminary survey instrument. The draft survey instrument was tested on a non-union contractor in South Florida, a union contractor in Southern California, a United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry local union in a Middle Atlantic state and a vo-tech training provider in north-central Florida. Extensive review of the survey instrument also was conducted with F-DOE and F-BAT representatives. Final review of the survey instrument and printing was completed in May 1993, with initial distribution on June 1, 1993.

Training Provider Contact

The researcher attempted to contact each of the identified training providers by telephone five calendar days prior to the June 1, 1993 initial survey instrument distribution. Ten calendar days after the initial mailing the researcher again attempted to contact telephonically each of the identified training providers who had not already responded. Twenty-eight days after the initial mailing, the researcher mailed an additional complete survey instrument to each of the 131 nonrespondents. The survey cutoff date was August 10, 1993, ten weeks after the initial mailing.

Craft Training Model Simulation Development

The system dynamics approach to understanding the construction craft training process began with an effort to understand the system of constraints that has created and sustained the craft training problems. Relevant data for understanding the problem were gathered from a variety of sources including a review of the relevant literature, interviews with informed persons at both the United States and Florida Departments of Education and Labor and specific quantitative investigations.

Initial craft training model development began with a set of logical diagrams showing the cause-and-effect correlation of the construction labor training process. The preliminary craft training model was simulated using one specific craft (electricians) to debug the mathematical equations. The model was then run with the entire set of construction industry craft training data. The output data from the model were then evaluated and compared with the BLMI employment projections. Probable

consequences of continuing current levels of construction craft training were then scrutinized.

Of primary interest during the development of the craft training simulation model was to have the model specifically identify the number of individuals who fill the labor demand for skilled craft workers and receive no initial, formal craft training. The model was constructed so that the only way to receive the skilled craft worker status of journeyman or foreman level was to enter the construction industry through a registered apprenticeship program with structured on-the-job training, through a vo-tech job prep program coupled with informal on-the-job training upon graduation, or though the helper route without any formal training and only informal on-the-job training. The last path is the area of major concern.

A simplified version of the craft training model is presented in Figure 3-1. A complete version of the model is presented in the next section.

The computer software utilized for this project was *Professional DYNAMO Plus*, published by Pugh-Roberts Associates, © 1986. This software was created to simplify the development and simulation of multiple variable models and/or processes. The programming language allows the researcher to concentrate on the correlations within the model instead of struggling with complex software programming problems. This software permitted the researcher to model the construction craft training process and among other things, calculate the number of individuals who fill the annual demand for skilled construction craft labor and receive no formal craft training.

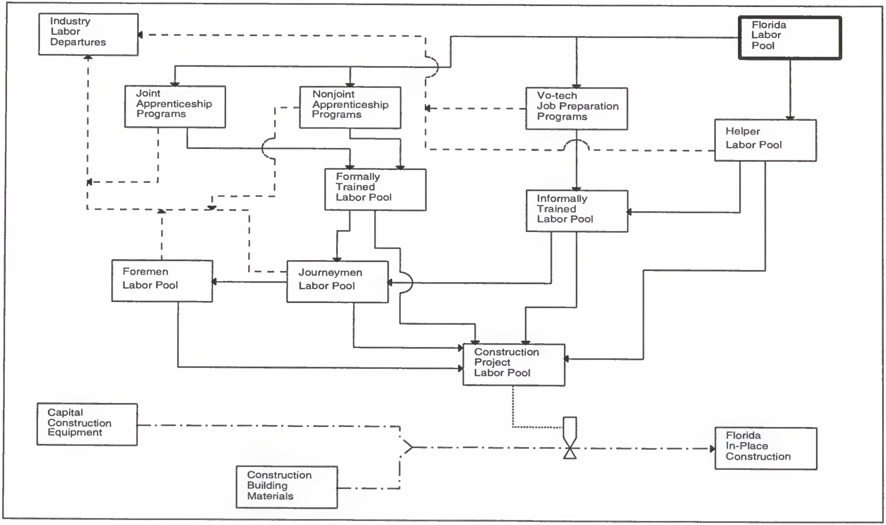


Figure 3-1 Construction industry craft training model

The model also was developed so that the researcher would be able to compare simulation results to the BLMI craft labor projections. A calculation variable was included in the model to track the total number of craft workers required (variable CPLR). This variable allowed the researcher to verify the model was running correctly and that the model's projected employment calculations closely matched the BLMI labor projections.

Cost Analyses

During the research process, it was discovered that apprenticeship training providers had the ability to contract with publicly funded educational institutions to furnish the academic portion of the training. In return, these educational institutions were able to claim FTE funding from F-DOE for each student. Information was requested from F-DOE to allow the researcher to calculate approximate FTE funding levels. Funding levels were calculated for both apprenticeship craft training and for construction-related vo-tech job prep training.

A series of questions was included in the primary survey instrument to help provide an accurate estimate of the training providers' variable cost of providing construction craft training. These questions also focused on the fees charged by the training provider to the student, contractor and public education finance committee. The question concerning cost to the public education finance committee was used to determine the accuracy of the responses to the cost questions.

Follow-up Survey Instrument Design

Each of the respondents to the primary survey instrument was given the opportunity to request a copy of the survey summary results. The researcher included a short follow-up questionnaire that tested the respondent's reaction to the proposed recommendations for improving construction craft training in Florida.

This entire research methodology was designed to describe the craft training process currently being conducted in Florida. The literature review indicated that there was no objective method to determine the appropriate amount of craft training which the construction industry should be conducting. This research was designed to be a first step in providing objective measures to determine suitable craft training levels.

CHAPTER IV
RESULTS AND DISCUSSION

The results of this research project and the discussion of the findings are broken into the following segments:

1. Analysis of the initial survey instrument results and program completion rate
2. Registered apprenticeship training programs
3. Estimates of unregistered apprenticeship training programs
4. Vocational and technical education job preparation programs
5. Model simulation results
6. Training cost analyses
7. Analysis of the follow-up survey instrument results

The survey instrument that was distributed to verifiable construction craft training providers covered topics not included in this dissertation. Therefore, only the relevant portions of the survey instrument are included in this section. A complete copy of the initial survey instrument and the follow-up survey instrument, including tabulation and interpretation of each of the responses, is included in Appendix A.

The statistical analysis technique employed on the initial questionnaire responses was a nonparametric one-way analysis of variance, in this case the *Wilcoxon test*. The nonparametric one-way analysis of variance method was chosen because the research questions were designed to detect response differences among the three groups of training providers--joint, nonjoint and vo-tech programs. The Wilcoxon technique

assigns a rank to each response, then computes a χ^2 value that is designed to detect differences among the three groups of training providers while eliminating the influence of outliers on the computed χ^2 value. The $\alpha = 0.05$ decision criterion tests the null hypothesis that the population mean response ranks are not significantly different. For values of $\Pr\{\chi^2\} \leq 0.05$, there is a significant difference among the sample mean ranks; for values of $\Pr\{\chi^2\} > 0.05$, there is no significant difference among the sample mean ranks. The symbol μ indicates mean response value.

Where appropriate, the symbol # was used to indicate the number of responses received from the training provider group--either joint apprenticeship program, nonjoint apprenticeship program, vo-tech job prep program or the total number of responses to the specific question. The symbol % was used to indicate the percentage of responses received from the training provider group. In some instances, the % column totals may add to greater than 100% since the respondents had the opportunity to choose more than one category.

Each of the respondents to the initial survey instrument was given the opportunity to request a summary copy of the survey results. Sixty of the training providers requested a summary copy of the results. The researcher included a short, follow-up survey instrument designed to test the training provider's impressions of the researcher's proposed recommendations. Statistically valid conclusions concerning the opinions of the entire training provider population cannot be drawn from the results of this follow-up survey.

Analysis of Initial Survey Instrument Results and Program Completion Rate

The overall response rate of training providers to the initial survey instrument was 38%. Responses were received from a representative cross section of each of the sample population subsets. Since the entire verifiable population of formal construction craft training providers was identified and sampled, statistically valid conclusions can be drawn from the data derived from the primary survey instrument. Table 4-1 is the analysis of the survey instrument response rate.

Table 4-1 Administration of the craft training program (see question #1 in Appendix A)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		State-Wide Totals	
	#	%	#	%	#	%	Total #	% of Total
Total number of training providers	58	100	39	100	64	100	161	100
Number of survey respondents	19	32	24	62	18	28	61	38
Number of surveys returned as undeliverable	3	5	5	13	*	*	8	5
Number of duplicate programs omitted from sample population	*	*	*	*	3	5	3	2
Number of surveys returned after the cutoff date	*	*	*	*	2	3	2	1

The researcher attributes the 28% response rate from vo-tech training providers as primarily due to the survey mailing dates in June. During this time frame, publicly funded postsecondary educational institutions are on summer break. In hindsight, the

survey instrument response rate from these institutions probably would have been higher if distribution had taken place during the normal September-to-May school year.

One subject is central to each of the sections that follow in this chapter: How do we retain the individuals who enter these training programs but elect to discontinue their training prior to completing the program? Although this question is not the principal focus of this treatise, it does influence the recommendations made.

One particular problem that needed to be addressed was to determine the expected apprenticeship completion rate for both the joint and nonjoint programs and the expected graduation rate for the vo-tech programs. Two questions were asked in the survey instrument that addressed these issues.

The expected completion or graduation rate (see question #14 in Appendix A) for the various programs was as follows:

Joint Apprenticeship Programs	$\mu = 63.9\%$
Nonjoint Apprenticeship Programs	$\mu = 51.1\%$
Vo-tech Job Preparation Programs	$\mu = 52.9\%$
Industry Average	$\mu = 54.4\%$

The statistical analysis of the responses to this question indicates no significant difference in the training program completion (or graduation) rates among the various programs (χ^2=0.2678). A statistical analysis of the completion rates, by craft, also was performed and showed no significant difference among the craft completion rates (χ^2=0.7020). The responses to this question indicate that approximately 4 of every 10 new apprentices drop out of the training programs before completing the training program.

The highest rate of student dropout (see question #15 in Appendix A) was expected to occur during the first year of training. The mean dropout rates were as follows:

Joint Apprenticeship Programs	μ = 7.7 months
Nonjoint Apprenticeship Programs	μ = 9.3 months
Vo-tech Job Preparation Programs	μ = 7.3 months
Industry Average	μ = 8.3 months

The statistical analysis of variance of the responses to this question indicates no significant difference in the dropout rate among the various programs (χ^2=0.1385). The dropout rate within the first year of training suggests either a lack of understanding of the realities of the construction industry by individuals entering craft training programs or the imposition of an impediment that prevents continuation of the training program.

Training providers indicated a belief that some form of industry awareness program would help reduce the training program dropout rate. Table 4-2 shows the response to the introduction of a preapprenticeship program. The follow-up survey tested the attitudes toward initiating a school-to-work transition program in the secondary school system. Reducing the training program dropout rate would allow for better utilization of scarce resources.

Table 4-2 Training provider's opinion that a one-year preapprenticeship program would help reduce the dropout rate (see question #16 in Appendix A)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Strongly agree	4	21	11	46	2	11	17	28
Moderately agree	8	42	9	38	10	56	27	44
Moderately disagree	4	21	2	8	4	22	10	16
Strongly disagree	3	16	2	8	2	11	7	12

Registered Apprenticeship Training Programs

The enrollment information in Table 4-3 shows the number of apprentices enrolled in both joint and nonjoint registered apprenticeship programs as of December 1992. This information was developed through research performed at the Florida Bureau of Apprenticeship in Tallahassee.

The information in Table 4-4 indicates the average annual level of apprentice completions for each of the identified crafts, the projected annual number of craft openings and the percentage of craft openings currently being filled by apprenticeship completers. The information describing projected number of craft openings was developed from the BLMI data published in the *Florida Industry and Occupational Employment Projections 1990 - 2005* (Florida Department of Labor and Employment Security, 1992).

Table 4-3 Current student enrollment in apprenticeship craft training programs

Craft	Number of Apprentices in Joint Programs	Number of Apprentices in Nonjoint Programs	Total
Boilermaker	0	0	0
Brick Mason & Stone Mason	38	5	43
Carpenter	259	31	290
Cement & Terrazzo Finisher	0	0	0
Electrician	474	933	1,407
Elevator Constructor	0	0	0
Equipment Operator	17	0	17
Insulator	67	0	67
Ironworker	140	0	140
Millwright	33	0	33
Painter	60	6	66
Plasterer, Lather & Drywall Finisher	7	0	[illegible]
Plumber	209	238	447
Pipe Fitter	189	[illegible]	191
Sprinkler Fitter	17	14[illegible]	447
Roofer	50	0	50
Sheet Metal Worker	186	110	296
Refrigeration Mechanic	14	201	215
Tile Setter & Marble Finisher	6	29	35
Other (Glazier)	2	2	4

Table 4-4 Registered apprenticeship completions and projected annual craft labor demand

Craft	Training Sponsor	Registered Apprenticeship Training Programs, State-Wide Total	Annual Average Number of Apprentice Completions	Projected Annual Number of Craft Openings	Percent of Annual Craft Openings Filled by Apprenticeship
Electrician	Nonjoint Joint Total	21 11 32	233 95 328	Growth 664 Depart. 648 Total 1,312	25
Plumber	Nonjoint Joint Total	16 9 25	60 42 102	Growth 481 Depart. 478 Total 959	19
Pipe Fitter	Nonjoint Joint Total	3 10 13	1 38 39	w /Plumber	w/Plumber
Sprinkler Fitter	Nonjoint Joint Total	6 1 7	35 8 43	w/Plumber	w/Plumber
Carpenter	Nonjoint Joint Total	10 6 16	8 65 73	Growth 975 Depart. 1,068 Total 2,043	0
Millwright	Nonjoint Joint Total	0 5 5	0 8 8	Growth 22 Depart. 37 Total 59	14
Flooring Installer	Nonjoint Joint Total	0 0 0	0 0 0	Growth 45 Depart. 43 Total 88	0
Drywall Finisher	Nonjoint Joint Total	0 0 0	0 2 2	Growth 103 Depart. 154 Total 257	1
Lather	Nonjoint Joint Total	0 1 1	0 2 2	Growth 8 Depart. 13 Total 21	0
Plasterer	Nonjoint Joint Total	1 2 3	0 2 2	Growth 38 Depart. 102 Total 140	0
Refrigeration Mechanic &/or HVAC Installer	Nonjoint Joint Total	11 2 13	67 4 71	Growth 371 Depart. 236 Total 607	12
Sheet Metal Duct Installer	Nonjoint Joint Total	11 4 15	26 47 73	Growth 41 Depart. 49 Total 90	81
Painter	Nonjoint Joint Total	2 4 6	2 20 22	Growth 645 Depart. 569 Total 1,214	2

Table 4-4--continued

Craft	Training Sponsor	Registered Apprenticeship Training Programs, State-Wide Total	Annual Average Number of Apprentice Completions	Projected Annual Number of Craft Openings	Percent of Annual Craft Openings Filled by Apprenticeship
Ironworker	Nonjoint Joint Total	1 0 1	0 47 47	Growth 70 Depart. 105 Total 175	27
Roofer	Nonjoint Joint Total	0 2 2	0 17 17	Growth 207 Depart. 142 Total 349	6
Equipment Operator	Nonjoint Joint Total	1 5 6	0 6 6	Growth 98 Depart. 96 Total 194	3
Tile Setter	Nonjoint Joint Total	1 2 3	10 2 12	Growth 29 Depart. 48 Total 77	16
Glazier	Nonjoint Joint Total	2 2 4	1 1 2	Growth 63 Depart. 76 Total 139	1
Asbestos Worker/ Insulator	Nonjoint Joint Total	1 3 4	0 17 17	Growth 45 Depart. 152 Total 197	9
Elevator Constructor	Nonjoint Joint Total	1 0 1	[illegible] 0 [illegible]	Growth 8 Depart. 13 Total 21	16
Stone Mason	Nonjoint Joint Total	0 3 3	0 0 0	Growth 5 Depart. 9 Total 14	6
Brick Mason	Nonjoint Joint Total	2 3 5	2 13 15	Growth 96 Depart. 147 Total 243	6
Concrete & Terrazzo Finisher	Nonjoint Joint Total	1 1 2	0 0 0	Growth 126 Depart. 336 Total 462	0
Boilermaker	Nonjoint Joint Total	0 0 0	0 0 0	Growth 6 Depart. 11 Total 17	0
Other Trades				Growth 239 Depart. 138 Total 377	
Totals	Nonjoint Joint Total	92 83 175	447 432 879	Growth 4,385 Depart. 4,670 Total 9,055	10

The data presented in Tables 4-3 and 4-4 indicate that, for virtually every craft within the industry, the current level of craft apprenticeship training in Florida is insufficient to meet the expected manpower needs of Florida's construction industry. Sheet metal duct installer is the exception due, primarily, to the low projected annual demand (90) and the high training level in the four joint programs (47 annual completions). Industry wide, the average annual level of apprenticeship completions is 879 completions per year; projected industry growth and separations average 9,055 per year. This information provides evidence that only 10% of the construction industry's annual demand for craft workers is being filled by formally trained craft workers.

Estimates of Unregistered Apprenticeship Training Programs

Estimates of the number of unregistered craft training programs were impossible to make. There was, however, ancillary evidence that some of these unregistered programs were being taught in the postsecondary vo-tech institutions. The F-BAT records indicated an enrollment level of 3,463 individuals in registered apprenticeship programs. The F-DOE records indicated an enrollment of 3,179 individuals in vo-tech apprenticeship programs, or 92% of the F-BAT number. There also were 4,526 individuals enrolled in vo-tech construction craft related supplemental (typically continuing education) training programs. The F-DOE does not require contractor organizations to register their "apprenticeship" training programs with the F-BAT as a precursor for these organizations to contract with publicly funded vo-tech programs to provide the academic portion of the craft training process. Officials at

F-DOE believes there are "unregistered apprenticeship" vo-tech training programs being offered in Florida; however, research conducted for this dissertation was not designed to detect these programs.

The reasons employer associations did not make the effort to register these programs was not clear, but the supposition was that they were either unwilling or unable to meet the F-BAT stipulations (see Chapter 2). Meeting these apprenticeship training program guidelines is not a difficult process. Virtually every national construction employer association provides apprenticeship training programs that have been approved by US-BAT. These are the same programs the local employer associations adopt and modify to meet the needs of local employers. Unless the national training program is drastically modified, F-BAT approval is a predictable and customary process.

Vocational and Technical Education Job Preparation Programs

The data in Tables 4-5 and 4-6 were derived from the vo-tech job preparation enrollment information for fiscal year 1991-1992. Table 4-5 includes total enrollment figures for construction-related vo-tech job prep programs. Table 4-6 shows the average annual level of job prep graduates for each of the identified crafts, adjusted for the expected drop-out rate; projected annual number of craft openings; and percentage of craft openings currently being filled by job prep graduates. The projected number of craft openings information was developed by the BLMI data.

Table 4-5 Current student enrollment in vo-tech job prep training programs

Craft	Number of Students in Vo-tech Job Prep Programs
Boilermaker	0
Brick Mason & Stone Mason	214
Carpenter	594
Cement & Terrazzo Finisher	0
Electrician	594
Elevator Constructor	0
Equipment Operator	0
Insulator	0
Ironworker	0
Millwright	0
Painter	0
Plasterer, Lather & Drywall Finisher	21
Plumber	311
Pipe Fitter	0
Sprinkler Fitter	0
Roofer	0
Sheet Metal Worker	13
Refrigeration Mechanic	3,059
Tile Setter & Marble Finisher	31
Other (Glazier)	1

Table 4-6 Vo-tech job preparation graduates and projected annual craft labor demand

Craft	Vo-tech Job Preparation Programs, State-Wide Total	Average Annual Number of Graduates	Projected Annual Number of Craft Openings	Percent of Annual Craft Openings Filled by Job Prep Graduates
Electrician	38	222	Growth 664 Separations 648 Total 1,312	2
Plumber	15	82	Growth 481 Separations 478 Total 959	9
Pipe Fitter	w/Plumber	w/Plumber	w/Plumber	w/Plumber
Sprinkler Fitter	1	2	w/Plumber	w/Plumber
Carpenter	54	157	Growth 975 Separations 1,068 Total 2,043	8
Millwright	1	1	Growth 22 Separations 37 Total 59	2
Flooring Installer	0	0	Growth 45 Separations 43 Total 88	0
Drywall Finisher	1	6	Growth 103 Separations 154 Total 257	2
Lather	0	0	Growth 8 Separations 13 Total 21	0
Plasterer	0	0	Growth 38 Separations 102 Total 140	0
Refrigeration Mechanic &/or HVAC Installer	43	810	Growth 371 Separations 236 Total 607	133
Sheet Metal Duct Installer	2	3	Growth 41 Separations 49 Total 90	3
Painter	0	0	Growth 645 Separations 569 Total 1,214	0
Ironworker	1	1	Growth 70 Separations 105 Total 175	1

Table 4-6--continued

Craft	Vo-tech Job Preparation Programs, State-Wide Total	Average Annual Number of Graduates	Projected Annual Number of Craft Openings	Percent of Annual Craft Openings Filled by Job Prep Graduates
Roofer	0	0	Growth 207 Separations 142 Total 349	0
Equipment Operator	0	0	Growth 98 Separations 96 Total 194	0
Tile Setter	2	8	Growth 29 Separations 48 Total 77	10
Glazier	1	0	Growth 63 Separations 76 Total 139	0
Asbestos Worker/ Insulator	0	0	Growth 45 Separations 152 Total 197	6
Elevator Constructor	0	0	Growth 8 Separations 13 Total 21	0
Stone Mason	0	0	Growth 5 Separations 9 Total 14	0
Brick Mason	27	16	Growth 96 Separations 147 Total 243	7
Concrete & Terrazzo Finisher	0	0	Growth 126 Separations 336 Total 462	6
Boilermaker	0	0	Growth 6 Separations 11 Total 17	0
Other Trades			Growth 239 Separations 138 Total 377	
Total (adjusted for Refrig. Mech.)	186	1,105	Growth 4,385 Separations 4,670 Total 9,055	12

The total average graduation column total is adjusted to projected labor demand for refrigeration mechanics. The projected annual number of construction craft

openings for refrigeration mechanics is the projected demand minus the annual number of apprenticeship graduates (607-71) or 536 annual openings. The supply of vo-tech job prep graduates is 271 individuals greater than the demand.

Construction Craft Training Model Simulation Results

The Construction Craft Training Model (Figure 4-1) shows the craft progression from unskilled and semiskilled to the skilled craft worker status of journeyman and foreman. The only means to achieve this skilled worker status is by (1) completing either a joint or nonjoint apprenticeship program with its structured and supervised on-the-job training component, (2) graduating from a vo-tech job prep program coupled with a period of informal on-the-job training upon graduation or by (3) progressing through the helper route and receiving only informal on-the-job training. Since it has already been shown that registered apprenticeship programs and vo-tech job prep programs fill only a small portion of the construction industry's annual demand for labor, the question arises: How many individuals fill the annual demand for skilled construction craft labor without receiving any formal skill training?

The construction craft training model and its computer simulation were designed to calculate the number of individuals who fill the demand for skilled construction craft workers but receive no formal craft training--the helper path. Initial craft levels in each of the labor pools were determined using the formula described by Levitt (1979) in *Union Versus Nonunion Construction in the U.S.* and the current percentages of unionized construction craft workers in the United States (20%) (Tomsho, 1993). The number of individuals enrolled in each of the joint and nonjoint

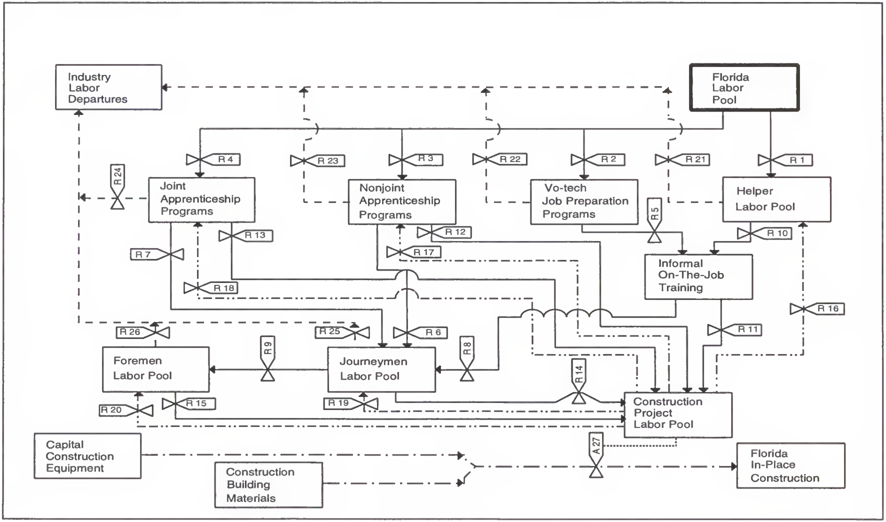


Figure 4-1 Construction industry craft training model

apprenticeship programs and the vo-tech job prep programs was determined using information provided by F-BAT and F-DOE. The annual level of industry separations and growth was determined from the BLMI data. All this information was used to determine the rate equations (R1 through R25) in the model. The construction craft training model was simulated using *Professional DYNAMO Plus* software published by Pugh-Roberts Associates, © 1986.

The computer simulation was first tested on the electrical construction trade. Electricians were chosen because the craft labor projections were straightforward and the craft training rates were among the highest in the industry. Once the model was tested and debugged using the electrical craft data, the model was reformulated to use craft training levels and projected labor demand data for the entire construction industry. The computer simulation results presented in this section apply to the entire construction industry. Complete simulation results for the construction industry and an explanation of each of the rate equations are included in Appendix B.

The areas of primary interest are the expected number of individuals completing both joint and nonjoint apprenticeship programs, expected number of individuals graduating from vo-tech job prep programs and projected demand for skilled craft workers during the 15-year calculation period. The analysis of the simulation model indicates that over the period of 1990 to 2005, the construction industry replacement demand for skilled craft workers--the separation and growth calculations for journeymen and foremen ($\sum$ of equations R5, R6, R7 & R8)--was calculated to be approximately 103,243 skilled craft workers. If there is no increase in

apprenticeship and/or job prep training, demand for skilled craft workers will be filled according to the following formulas:

The supply of craft workers graduating from vo-tech job prep programs is expected to be

$$\sum_{y=1990}^{2005} R_5 = 17,440$$

The supply of craft workers completing nonjoint apprenticeship programs is expected to be

$$\sum_{y=1990}^{2005} R_6 = 7,152$$

The supply of craft workers completing joint apprenticeship programs is expected to be

$$\sum_{y=1990}^{2005} R_7 = 6,912$$

The projected demand for skilled labor is expected to be

$$\sum_{y=1990}^{2005} (R_8 + R_7 + R_6) = 103,243$$

The expected labor departures from the skilled labor pools (journeymen and foremen) is also of concern:

$$\sum_{y=1990}^{2005} (R_{25} + R_{26}) = 39,852 + 14,907 = 54,759$$

Using these calculations, joint apprenticeship programs are expected to fill

6.7% of the demand for skilled workers, nonjoint apprenticeship programs are expected to fill 6.9% of the demand for skilled workers, vo-tech job prep programs are expected to fill 16.9% of the demand for skilled workers, while approximately 69.5% of the demand for skilled craft workers will be filled by individuals who have received no formal craft training (see Table 4-7).

Table 4-7 "Skilled" craft worker training route

Training Route	Number of "Skilled" Craft Workers	Percent of "Skilled" Craft Workers
Helper with informal on-the-job training	71,739	69.5
Vo-tech job prep with informal on-the-job training	17,440	16.9
Nonjoint apprenticeship with formal on-the-job training	7,152	6.9
Joint apprenticeship with formal on-the-job training	6,912	6.7
Total	103,243	100

This model also indicates that the expected number of formal apprenticeship completions is insufficient to replace the number of supervisory craft workers (foremen) leaving the industry during this calculation period (14,907 departures vs. 14,064 completions).

The initial journeymen and foremen labor pool levels were 110,059 and 41,127 craft workers, respectively, or an estimated total of 151,186 skilled craft workers in the construction labor pool. This calculates to one skilled craft labor force turnover approximately every 22 years.

$$\frac{151{,}186 \ \textit{Original Skilled Craft Labor Pool Level}}{\dfrac{103{,}243 \ \textit{New Entrants into Skilled Labor Pool}}{15\text{-}\textit{Year Calculation Period}}} = 22 \ \textit{years}$$

Therefore, by the year 2015, unless the current levels of formal construction craft training are increased significantly, approximately 70% of the "skilled" craft work force will have received the majority of their training by observing other craft workers who may or, more likely, may not know how to properly perform the work. The current levels of construction craft training will lead to a serious decline in the skill level of the construction craft work force.

Figures 4-2, 4-3 and 4-4 show projected demand for skilled craft workers and sources of craft training. Figure 4-2 shows projected demand, both growth and departures, and the increasing industry reliance on informal on-the-job training as the primary skill development tool and training source for the craft work force. Figure 4-3 shows projected growth of the skilled craft work force and supply of formally trained craft workers. Figure 4-4 shows projected departures of the skilled craft work force and supply of formally trained craft workers.

Interestingly, the supply of apprenticeship-trained craft workers is approximately equal to either the projected craft labor growth or the projected number of craft departures of foremen-level craft workers, but not both. In addition the supply of vo-tech-trained craft workers is insufficient to meet either the projected growth or the projected number of departures of journeymen-level craft workers.

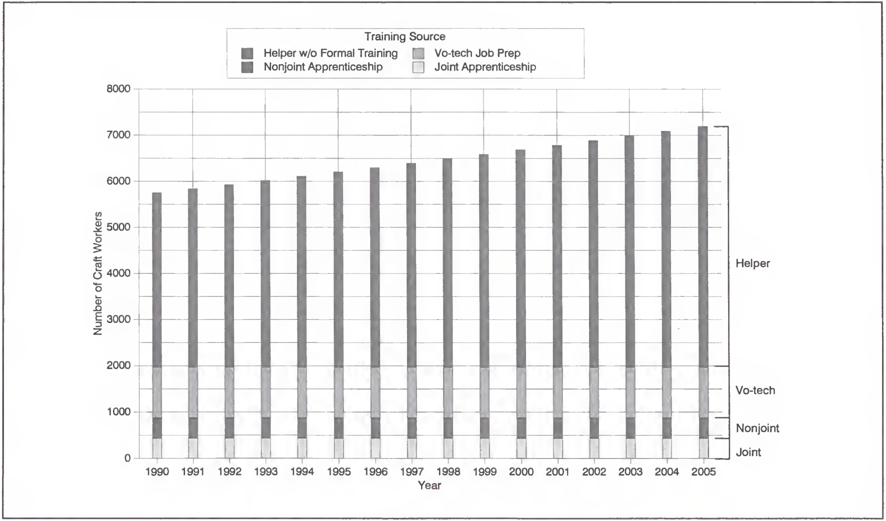


Figure 4-2 Source of craft training for workers filling the demand for journeymen- and foremen- level craft workers

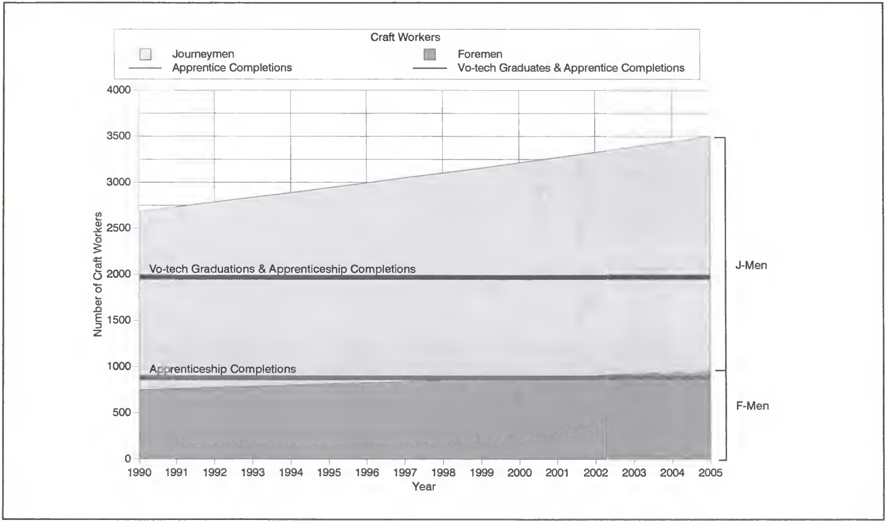


Figure 4-3 Projected skilled labor growth and the supply of formally trained craft workers

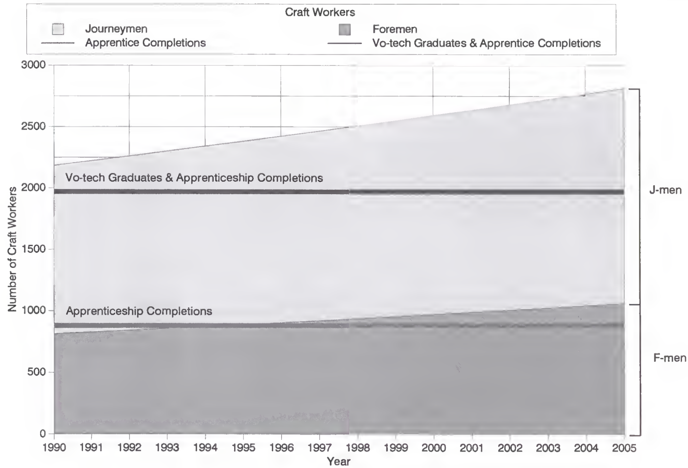


Figure 4-4 Projected skilled labor departures and the supply of formally trained craft workers

Construction Craft Training Cost Analyses

Many cost items must be considered when analyzing the expense of providing construction craft training, including, but not limited to, the following:

1. Tooling & equipment costs
2. Training material costs
3. Instructor salaries
4. Instructor continuing education training
5. Facilities overhead
6. Administrative overhead

A series of questions was asked of the training providers to determine these costs, and others, and to determine any possible revenue sources and funding amounts. Responses to these questions were met with incomplete results that will be discussed later in this section.

One of the first items that had to be considered was to determine the existing training program's maximum yearly training capacity for new students (see question #11 in Appendix A). The mean responses for the individual training programs were

Joint Apprenticeship Programs	$\mu = 25$ students
Nonjoint Apprenticeship Programs	$\mu = 23$ students
Vo-tech Job Preparation Programs	$\mu = 16$ students
Industry Average	$\mu = 24$ students

The statistical analysis of variance of the responses to this question indicates no significant differences in the maximum yearly training capacity of the various programs (χ^2=0.3254). The responses to this question indicate that a maximum yearly class size of 20 to 25 students would be possible for the existing training infrastructure.

The most costly item faced by construction craft training providers is investment in physical training facilities. Tables 4-8, 4-9 and 4-10 present the responses of the training providers as to adequacy of existing training infrastructure, classroom facilities, shop facilities and administrative facilities. Responses to these questions indicate that the current classroom, shop and administrative facilities used to provide construction craft training are considered adequate for existing training levels.

Table 4-8 Adequacy of existing classroom facilities (see question #18 in Appendix A)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	4	%	4	%	#	%	Total #	% of Total
Fully adequate	1[illegible]	79	10	42	10	56	35	57
Moderately adequate	4	21	12	50	5	28	21	34
Moderately inadequate	*	*	1	4	3	17	4	7
Completely inadequate	*	*	*	*	*	*	*	*

Table 4-9 Adequacy of existing shop facilities
(see question #19 in Appendix A)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	4	%	4	%	#	%	Total #	% of Total
Fully adequate	14	74	7	29	8	44	29	48
Moderately adequate	4	21	13	54	5	22	22	36
Moderately inadequate	1	5	3	13	5	28	9	15
Completely inadequate	*	*	1	4	*	*	1	2

Table 4-10 Adequacy of existing administrative facilities
(see question #20 in Appendix A)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	4	%	4	%	#	%	Total #	% of Total
Fully adequate	14	90	15	63	10	56	42	69
Moderately adequate	2	11	7	29	4	22	13	21
Moderately inadequate	*	*	1	4	2	11	3	5
Completely inadequate	*	*	*	*	1	6	1	2

A final question concerning training facilities asked whether the location of the training program meets the needs of the students. Responses to this question indicate the current location of the facilities were adequate to meet the needs of the students.

Table 4-11 Adequacy of training facility location
(see question #34 in Appendix A)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	4	%	4	%	#	%	Total #	% of Total
Fully adequate	14	74	14	46	11	61	36	59
Moderately adequate	4	21	13	54	7	39	24	39
Moderately inadequate	*	*	*	*	*	*	*	*
Completely inadequate	*	*	*	*	*	*	*	*

The responses of the training providers indicate that the existing training infrastructure is adequate to meet current enrollment needs. To determine the mean annual enrollment in existing training programs, the current average level of annual joint and nonjoint apprenticeship completions and vo-tech graduations data in Tables 4-4 and 4-6 can be compared with the verified number of training programs, also in Tables 4-4 and 4-6. The following is a comparison of the mean current annual student enrollment calculations for the various programs with the mean annual training capacity data:

	Mean Enrollment	Mean Capacity
Joint Apprenticeship Programs	μ = 5 students	μ = 25 students
Nonjoint Apprenticeship Programs	μ = 5 students	μ = 23 students
Vo-tech Job Preparation Programs	μ = 6 students	μ = 16 students
Industry Average	μ = 5 students	μ = 24 students

This comparison indicates a conspicuous underutilization of capacity in existing training programs, which suggests that major capital investments would not be required

to develop additional training facilities if there were a significant (200%) increase in construction craft apprenticeship training.

A series of questions was asked of the training providers in an attempt to determine:

1. Annual training program budget
2. Annual cost to the student
3. Annual cost per student to the contractor
4. Annual cost per student to the public education finance committee
5. Program's estimated annual expenditure per student

The response to the question concerning the annual training budget (question #28 in Appendix A) was insufficient to draw any statistically valid conclusions; however, the few complete responses that were received suggested a yearly training budget of approximately $1700 per student.

The responses to the question concerning annual cost (fees, books and tuition) to the student (question #29 in Appendix A) produced the following mean costs:

Joint Apprenticeship Programs	$\mu =$ $67.86
Nonjoint Apprenticeship Programs	$\mu =$ $66.42
Vo-tech Job Preparation Programs	$\mu =$ $505.07
Industry Average	$\mu =$ $219.91

The statistical analysis of variance of the responses to this question indicates no significant difference in the cost to the student among the joint and nonjoint (χ^2=0.8896) programs; however, there is a significant difference in the cost to the student among the vo-tech programs and the joint (χ^2=0.0001) and nonjoint (χ^2=0.0002) programs. The responses to this question indicate the cost to the students is significantly higher in the vo-tech programs than in the joint or nonjoint programs,

which is not surprising since vo-tech students typically pay for their own books, fees and tuition, while the joint and nonjoint students typically pay only for books.

The responses to the question concerning the annual cost per student to the contractor (question #30 in Appendix A) produced the following mean costs:

Joint Apprenticeship Programs	μ = \$/hour assessment
Nonjoint Apprenticeship Programs	μ = \$313.68
Vo-tech Job Preparation Programs	μ = \$301.67
Industry Average	μ = \$312.05

The statistical analysis of variance of the responses to this question indicates no significant differences in the cost per student to the contractor among the nonjoint and the vo-tech programs (χ^2=0.9999). The contractor cost for the joint programs is directly dependent upon the number of craft hours worked and is, therefore, variable from year to year and from contractor to contractor. The responses to this question indicate a strong tie between apprenticeship programs and vo-tech training providers.

The responses to the question concerning the annual cost per student to the public education finance committee (question #31 in Appendix A) produced the following mean costs:

Joint Apprenticeship Programs	μ = \$3176.57
Nonjoint Apprenticeship Programs	μ = \$3912.00
Vo-tech Job Preparation Programs	μ = \$3884.42
Industry Average	μ = \$3788.70

The statistical analysis of variance of the responses to this question indicates no significant differences in the cost to the public education finance committee among the various programs (χ^2=0.1159). Seven of the 19 joint programs (37%) and 20 of the 24 nonjoint programs (83%) report receiving public funding. Officials at the F-DOE

hypothesize, and this is supported by enrollment data, that there is a higher percentage of joint apprenticeship programs taught in publicly funded institutions than the 37% who reported FTE funding (vo-tech programs report enrolling 92% of all registered apprentices).

The question concerning the program's estimated expenditure to educate each student per year (question #32 in Appendix A) produced the following mean costs:

Joint Apprenticeship Programs	μ = $2381.21
Nonjoint Apprenticeship Programs	μ = $992.92
Vo-tech Job Preparation Programs	μ = $3072.00
Industry Average	μ = $1990.13

The statistical analysis of variance of the responses to this question indicate no significant difference in the program expenditures among the joint and vo-tech (χ^2=0.0904) programs; however, there is a significant difference in the program expenditures among the nonjoint and the joint (χ^2=0.0236) and vo-tech (χ^2=0.0316) programs. The responses to this question indicate the nonjoint programs devote fewer monetary resources to craft training than do the other programs.

The cost information presented on the previous pages (questions 29, 30, 31 and 32 in Appendix A) must be considered suspect. The annual cost per student to the public education finance committee is based on FTE funding from the Department of Education and is conspicuously different than actual funding provided. The reasons for these discrepancies may be that

1. The individual was unaware of the actual dollar amounts.
2. The individual was confused about what the question was asking.

3. The funding levels were considered confidential by the individual committees.
4. The individual purposely responded with inaccurate information.
5. The dollar amounts may be skewed due to sample size.
6. All training costs may not have been considered.

The actual equation for determining program funding allocations from the F-DOE is

$$\mathit{FTE} * \begin{matrix} \textit{program} \\ \textit{cost} \\ \textit{factors} \end{matrix} =$$

$$\begin{matrix} \textit{weighted} \\ \textit{FTE} \\ \textit{students} \end{matrix} * \begin{matrix} \textit{base} \\ \textit{student} \\ \textit{allocation} \end{matrix} * \begin{matrix} \textit{district} \\ \textit{cost} \\ \textit{differential} \\ \textit{factor} \end{matrix} + \begin{matrix} \textit{declining} \\ \textit{enrollment} \\ \textit{supplement} \end{matrix} + \begin{matrix} \textit{sparsity} \\ \textit{supplement} \end{matrix} + \begin{matrix} \textit{hold} \\ \textit{harmless} \\ \textit{adjustment} \end{matrix}$$

$$= \begin{matrix} \textit{STATE} \\ \textit{PLUS} \\ \textit{LOCAL} \\ \textit{FEFP} \\ \textit{DOLLARS} \end{matrix}$$

Where

Program Cost Factor	=	Determined by the Legislature
Base Student Allocation	=	Determined by the Legislature
District Cost Differential	=	Determined by the Commissioner
Declining Enrollment Supp.	=	Calculated Annually
Sparsity Supplement	=	Based upon Population
Hold Harmless Adjustment	=	Based upon Enrollment

The FTE funding equation can be reduced to an equation that is applicable to each school district. The simplified equation for arriving at the appropriate FTE funding dollar amount for apprenticeship is

$$FTE_A = \frac{W_n * HRS_w}{HRS_s} * FTE_{iw} * FTE_b$$

Where

FTE_A	=	FTE dollar allocation per apprentice
FTE_{iw}	=	Industrial Education weighted FTE
FTE_b	=	FTE base dollar value
HRS_w	=	Yearly hours per week of on-the-job training
HRS_s	=	Standard hours per year (180-day/year program)
W_n	=	Number of weeks worked per year

Therefore, using fiscal year 1991-1992 data, the apprenticeship FTE funding allocation was

$$\$5,131.04 = \frac{50 * 25}{900} * 1.477 * \$2501.05$$

This dollar allocation to the public education finance committee is clearly in excess of the $3788.70 calculated using the responses provided by the construction craft training providers.

Additional information has been provided by the F-DOE to more accurately estimate the FTE funding for both joint and nonjoint apprenticeship training programs in Florida. Postsecondary, publicly funded, vocational and technical education centers located throughout the state reported, for funding purposes, 3,179 construction trades

apprentices enrolled during fiscal year 1991-1992. A further breakdown of this figure estimates that approximately 1,893 of these apprentices are enrolled in joint apprenticeship programs, with the remaining 1,286 apprentices enrolled in nonjoint apprenticeship programs. Therefore, estimated FTE funding for construction apprenticeship is approximately \$9,713,058 annually for joint training programs and \$6,598,518 annually for nonjoint training programs, or a total of \$16,311,576 annually for vo-tech centers only.

The FTE funding calculation for the construction craft related job preparation training programs at vo-tech centers vary slightly:

$$FTE_{JP} = FTE_{iw} * FTE_{b}$$

Where

FTE_{JP}	=	FTE dollar allocation per job prep student
FTE_{iw}	=	Industrial Education weighted FTE
FTE_{b}	=	FTE base dollar value

Therefore, using fiscal year 1991-1992 data, the vo-tech FTE funding allocation was

$$\$3,694.05 = 1.477 * \$2501.05$$

Information provided by the F-DOE indicates there were approximately 5,095 students enrolled in construction-related vo-tech job prep programs during fiscal year 1991-1992. Therefore, the FTE funding for vo-tech job prep programs for fiscal year 1991-1992 was approximately \$18,821,189.

The cost of construction-related craft training, both apprenticeship and job preparation, funded through F-DOE's vocational and technical training programs was approximately \$16,311,576 for apprenticeship training and \$18,821,189 for job preparation training, or a total of \$35,132,765 for fiscal year 1991-1992. If the

variations in individual craft apprenticeship training program durations are considered, the average annual number of apprenticeship completions is approximately 879 per year, or an average funding level of approximately $18,900 per apprenticeship completion. If the projected dropout rate is considered for job preparation programs, the average annual number of job prep graduates is 1,308 students, or an average annual funding level of approximately $14,390 per job prep graduate.

The F-DOE currently establishes enrollment ceilings or caps for the adult job preparatory--vocational and adult supplemental--vocational program group titles (Florida Department of Education, 1993). If these ceilings were raised to allow a 200% increase in apprenticeship training levels (80% of the calculated demand), the additional annual funding requirement would be approximately $33 million of additional FTE funding, or a total annual FTE funding of approximately $68 million state wide.

Florida Statute §239.117 specifies students who are enrolled in approved apprenticeship programs are exempt from any requirement for the payment of fees for instruction, provided the contributions of facilities, personnel or equipment made on behalf of the students equal or exceed the total value of fee exemptions (Florida Department of Education, 1993). The postsecondary adult education instruction fees for fiscal year 1993-1994 range from $0.33 to $0.63 per contact hour, with the norm being $0.56. The Fitzgerald Act requires "a minimum of 144 hours per year of organized technical instruction." The number of contact hours per year in apprenticeship programs typically ranges from 150 hours to 180 hours per year. Therefore, for craft apprenticeship training programs taught in postsecondary

institutions, the apprenticeship committee contribution in facilities, personnel or equipment must equal approximately $100.00 per apprentice per year (180 contact hours * $0.56 = $100.80). If these costs are passed directly to the customer, assuming the apprentice works the normal 2,000 hours per year (50 weeks * 40 hours/week), the cost to the customer would be approximately $0.05 per apprentice manhour.

Analysis of Follow-up Survey Instrument

Each of the respondents to the initial survey instrument was given the opportunity to request a summary copy of the survey instrument results. Sixty of the training providers requested a summary copy of the results. The researcher included an additional survey instrument designed to test the training provider's opinions concerning the following proposed recommendations. Statistically valid conclusions concerning the opinions of the entire training provider population cannot be drawn from the results of this follow-up survey. Tables 4-12 through 4-21 are the question summaries of the follow-up survey instrument.

Table 4-12 Introduction of career awareness programs in Florida's middle schools

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
23	85	4	15	*	*	*	*

Table 4-13 Introduction of school-to-work transition and/or youth apprenticeship programs in Florida's high schools

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
20	74	4	15	1	4	2	7

Table 4-14 Development of stronger contractor ties with postsecondary construction craft training providers

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
20	74	4	15	2	7	1	4

Table 4-15 Apprenticeship training providers contracting with postsecondary institutions to provide the academic-related instruction

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
15	56	9	33	1	4	2	7

Table 4-16 Requiring standard skill certification of all apprenticeship graduates

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
20	74	5	19	2	7	*	*

Table 4-17 Requiring standard skill certification of all vo-tech job prep graduates

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
18	67	9	33	*	*	*	*

Table 4-18 Requiring all construction craft instructors to complete six construction- and/or craft-related continuing education units every two years

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
10	37	10	37	5	19	2	7

Table 4-19 State of Florida providing tax incentives to contractors who establish and maintain registered apprenticeship training programs

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
18	67	7	26	*	*	2	7

Table 4-20 Increasing the annual number of apprenticeship graduates from 879 per year to 2,700 per year within 5 years (a 200% increase)

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
14	51	7	26	1	4	5	19

Table 4-21 Increasing the Department of Education funding to expand the number of apprenticeship graduates

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
17	62	4	15	1	4	5	19

The responses to the follow-up survey indicate a strong to moderate agreement from the training providers to each of the proposed recommendations. Implementation of these recommendations and potential execution impediments are be discussed in the Recommendations section of Chapter V.

CHAPTER V
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This concluding chapter presents a summary of the research findings, conclusions drawn from the research, recommendations for improving construction craft training in Florida and recommendations for further research. The final section includes concluding remarks from the researcher.

Summary

The central hypothesis of this study was that the construction industry was training insufficient numbers of individuals to meet the industry's annual demand for skilled craft workers. The U.S. Department of Labor study *How Workers Get Their Training: A 1991 Update* (Bureau of Labor Statistics, 1992) illustrated that, nationally, 38% of the construction trades work force reported receiving some type of informal on-the-job training (of these individuals, approximately 10% also reported receiving postsecondary school-based job preparation training), 19% of the work force reported a formal company-based program as their source of training (apprenticeship programs), 4% reported receiving "other" training, with the remaining 39% of the craft work force declaring they have received no formal or informal craft training. Other construction industry observers suggested the construction industry was providing training opportunities to approximately two-thirds of the projected number of craft workers needed by the industry (Gasperow, 1990). The purpose of this study was to test this

premise by using Florida as a paradigm, quantifying the actual number of individuals in formal construction craft training programs, and developing a simulation procedure that accurately delineates Florida's annual need for skilled construction craft workers.

The literature review indicated construction industry observers consider vo-tech job preparation training a complement to apprenticeship training, not a substitute for apprenticeship training. Classroom-only, construction-related job prep training was viewed as providing only elementary vocational skills and deficient in providing the student with crucial elements of career preparedness (Kenny, 1988). The formal structure and skilled craft worker supervision of the apprentice's on-the-job training were considered the most valuable sources of skill development. However, the literature also suggested the theoretical aspects of each craft was most effectively presented in an academic setting (Rubens, 1980).

The research procedure at F-BAT and F-DOE identified every registered craft training provider in Florida. These identified craft providers were subdivided into three groupings: joint apprenticeship training providers, nonjoint apprenticeship training providers and vo-tech job preparation training providers. A survey instrument was designed and distributed to each of the identified training providers. The statistical analyses, which used a nonparametric one-way analysis of variance technique, were designed to detect response differences among the three groups of training providers. Since the entire verifiable population of formal construction craft training providers was identified and sampled, and a 38% overall response rate to the survey instrument was generated, statistically valid conclusions can be drawn from the data derived from the primary survey instrument.

A systems dynamics model of the construction craft training process was developed that utilized information derived from the construction craft training provider survey and the BLMI's annual industry and occupational employment projections. The model simulation verified that only 16% (900 individuals) of the industry's projected annual demand for journeyman-level craft workers (5,750 individuals) was being filled by apprenticeship program completers, with an additional 19% (1,100 individuals) of the yearly demand being filled by semi-skilled vocational and technical education job preparation program graduates. The results of the construction craft training model simulation indicated that annual apprenticeship completions were scarcely sufficient to fill either the annual projected departures (813 individuals) or the annual expected growth (747 individuals) for foreman-level craft worker labor pool, but not both. Simulation results also indicated that annual job prep graduations were explicitly incapable of filling either annual projected departures (2,185 individuals) or annual expected growth (2,005 individuals) for the journeyman-level craft worker labor pool. This investigation confirmed that Florida's construction industry is providing the craft work force with insufficient formal training opportunities.

The State of Florida currently provides approximately $35 million annually to support postsecondary construction craft training programs. If vo-tech job preparation program training levels remain constant and apprenticeship training programs taught in publicly funded educational institutions are increased by 200% over the next five years (from approximately 900 annual completions to 2,700 annual completions), the state FTE expenditure for support of construction craft training will be approximately $68

million annually (1993 dollars). Although this additional $33 million of FTE funding may seem like an unreasonably high figure, it represents an increase in F-DOE FTE funding of approximately 0.7% over 1993-1994 appropriation levels of $4,526,812,758 (Florida Department of Education, 1993).

The model simulation also suggested the skilled craft labor work force turnover rate is approximately once every 22 years. If there is no increase in construction craft training, by the year 2010 the percentage of the construction work force having received some type of formal craft training will have dropped to 22%, with 78% of the craft work force having received only informal on-the-job training or, more likely, no training at all.

Increasing construction craft training levels decreases employee turnover by 18%, increases productivity by an average of 18% and results in an average rate of return on the training investment of 2:1 (Liska, 1994). Completion of a formal craft training program also beneficially affects employee on-the-job safety by reducing accident frequency, which lowers contractors' workers compensation costs (Dedobbeleer, Champagne and German, 1990). Everything presented in this treatise supports increasing construction craft training efforts, and review of the relevant literature found no studies that suggested any drawbacks associated with craft training.

Conclusions

This analysis of construction craft training presented the general belief of industry observers that increasing the current levels of craft training would benefit the construction industry by

1. Reducing industry-wide craft labor departures,
2. Increasing the quality of the constructed product,
3. Increasing the individual's productivity,
4. Reducing the contractor's worker's compensation costs, and
5. Increasing the craft worker's lifetime earning potential.

To realize these expected benefits, the industry must develop increased contractor commitment, specifically from the nonunion sector of the industry, to support, promote and expand current levels of apprenticeship craft training (Rubens and Harrisson, 1980; Metcalf, 1985).

The construction craft training simulation model confirmed the industry is training insufficient numbers of craft workers to meet the annual labor demand for skilled craft workers. If the industry were to increase its commitment to craft training and provide apprenticeship opportunities to workers at approximately 80% of the annual demand for skilled workers, a 200% increase in apprenticeship training levels would have to occur.

It is difficult to understand why contractors in Florida are either unwilling or unable to increase apprenticeship training levels. There are virtually no barriers to implementing improved craft training programs. Florida Statute §239.117 exempts students enrolled in approved apprenticeship programs from the payment of tuition. This exemption means that there is no cost to the student for instruction if the apprenticeship committee contracts with a local public education committee or institution. The negotiated cost to the apprenticeship committee would, therefore, be reduced to the contributions of facilities, personnel, tools and training materials that must equal or exceed the total value of the fee exemptions.

Training Provider Recommendations

The follow-up survey instrument tested the initial survey respondents' attitudes toward the proposed recommendations in this section. In every case, the follow-up survey respondents supported the following recommendations.

Secondary Education System

The principal recommendation for the secondary school system is to implement construction-related school-to-work transition programs. Ideally, these programs would begin in the 7^{th} through 10^{th} grades with a career awareness program that would be coupled with both site and employer visits. The school system would then establish a "youth apprenticeship" partnership with local contractor organizations. In the 11^{th} grade, students would spend 30% of their time receiving on-the-job construction craft training (typically during the summer months). By the 12^{th} grade students would spend 50% of their time receiving on-the-job training (one semester of the school year), with the remaining 50% of their time spent on required academic instruction supplemented with craft-related instruction. Upon graduation students would be tested and receive a Standard Skill Certification if they passe the examination.

Virtually every national contractor trade organization provides a skill development curriculum. There is no need for school districts to "reinvent the wheel" when it comes to construction-related curricula. These existing training curricula can be modified to fit the needs of individual programs.

At the time of this writing, there is also a push in Florida to establish school-to-work transition programs in the form of tech prep and youth apprenticeship

programs. Orange and Seminole counties in Florida (Orlando area) have established construction craft youth apprenticeship programs at the secondary school level.

There is also a national belief that some form of school-to-work transition program is necessary at both the secondary and postsecondary level. Senate Bill 1993 S. 1396 will provide seed money to the states to facilitate youth apprenticeship demonstration projects. A focus of this legislation is to provide career awareness that will, hopefully, reduce the squandering of training funds and resources at the postsecondary level.

Postsecondary Education System

The postsecondary educational institutions that provide construction craft training programs, both job prep and apprenticeship, should develop stronger ties with local contractor organizations. This would benefit both parties. Strong contractor ties would allow the school to know if the provided training meets industry needs and would provide contractors with access to a better-trained work force.

Each graduate of a vo-tech job prep training program should be required to complete a Standard Skill Certification examination. Only by the uniform testing of each graduate would program training effectiveness be determined.

Apprenticeship Training System

Apprenticeship training providers should contract with local postsecondary educational institutions, wherever practical, to provide the academic portion of

apprenticeship training. This arrangement would allow the apprenticeship committee access to state funding.

Each graduate of an apprenticeship training program should be required to complete a Standard Skill Certification examination. Only by the uniform testing of each apprentice would program training effectiveness be determined.

Construction Craft Training Instructors

The paramount problem with providing high-quality construction craft training is providing erudite, craft-orientated instructors. The minimum requirements for each craft training instructor should be completion of a formal craft apprenticeship program, a journeyman's license in the specific craft and a minimum of two years' experience at the journeyman level.

The skills and abilities of the craft instructors are paramount to the effectiveness of the training program. To enhance the caliber of instruction, construction craft training instructors should be certified as instructors in the particular craft. Craft training instructors also should be required to complete six construction- and/or craft-related continuing education units every two years.

State of Florida

It is implausible to expect that the State of Florida could mandate Journeyman-level craft worker licensing for all crafts. However, since the state is contributing significant resources in support of construction craft training, the state would be well advised to mandate craft worker skill certification for all job prep and apprenticeship

training programs supported with public funds. Since the quality of instruction varies from program to program, this is the only feasible way to determine training program effectiveness.

The vast majority of construction craft training programs are being taught in state-funded secondary and postsecondary educational institutions. Since the state is currently underwriting these craft training programs, the state also has the responsibility to supervise instructor competence. A primary method of guaranteeing instructor expertise is to legislatively mandate certification of craft training instructors.

The State of Florida should provide tax incentives for construction contractors who establish and maintain *registered* craft apprenticeship training programs. Since apprenticeship committees already have the ability to contract with both secondary and postsecondary educational institutions to provide training, the tax incentives should encourage, and also be limited to, the deduction of any fees collected by the apprenticeship committee and the cost of materials and tooling donated to the training programs.

The F-DOE currently has established enrollment ceilings (caps) for adult job preparatory vocational programs. These enrollment ceilings should be raised to at least 80% of the annual calculated demand for construction craft apprentices.

The State of Florida has, as its primary interest, the goal of providing broad-based construction craft training. The funding levels in excess of $35 million annually and the cyclical nature of the industry dictate the need for broad-based training so individuals will have enough skills to be able to get a job on the next construction project. Narrowly based craft skills will not ensure continuing industry employment.

Recommendations for Further Research

Craft Training Providers

A longitudinal study should be undertaken to see how many of the individuals completing both vo-tech job prep and formal apprenticeship training programs continue working in the industry. This type of study could be conducted entirely in Tallahassee by using F-DOE's student records (the student's social security number) and BLMI's employer records (the employee's social security number). Longitudinal studies of this nature would require mainframe computer capability due to the size of the database searches. The benefits of this study would be to help determine training program effectiveness by identifying the number of individuals who have received formal craft training and have left the industry after completing their training. Those crafts with the highest dropout rates could be targeted for further research.

The other area of further research on craft training providers would be to perform craft training simulation for each of the individual construction crafts. This would help to determine the appropriate training level for each of the individual crafts.

Training Provider Funding Methods

A secondary objective of this investigation was to develop a cost analysis of the construction craft training process. It became apparent during the research phase that the apportionment allocated to the craft training programs was significantly less than the FTE funding levels. The final recommendation for further research would be to conduct a comprehensive analysis of the construction craft training program funding

process to determine actual funding levels and verify where and how the money is actually being spent.

Concluding Remarks

Objective evidence was presented confirming that the current levels of construction craft training are shamefully short of the needs of Florida's construction industry. Without significant increases in craft training levels, serious shortages of skilled craft workers will occur, and these shortages will adversely affect the industry. The construction craft training simulation model presented in this investigation is a tool that can be used by craft training providers and policy setters to determine appropriate levels of construction craft training.

APPENDIX A

CONSTRUCTION CRAFT TRAINING PROVIDER SURVEY

This appendix is the summary of the survey instruments distributed to Florida's construction craft training providers. The first section is the summary of the initial survey instrument and the second section is the summary of the follow-up survey instrument.

Summary of the initial survey instrument responses received from Florida's construction craft training providers

The statistical analysis technique employed on the initial survey instrument responses was a nonparametric one-way analysis of variance, in this case the ***Wicoxon test***. This technique assigns a rank to each response, then computes a χ^2 value that is designed to detect differences among the three groups of training providers--joint apprenticeship (union), nonjoint apprenticeship (nonunion) and vocational and technical education job preparation programs--while eliminating the influence of outliers on the computed χ^2 value. The $\alpha = 0.05$ decision criterion tests the null hypothesis that the population mean response ranks not significantly different. For values of $\Pr\{\chi^2\}\leq 0.05$, there is a significant difference among the sample mean ranks; for values of $\Pr\{\chi^2\}>0.05$, there is no significant difference among the sample mean ranks. Since the entire population of verifiable construction craft training providers was identified and surveyed, statistically valid conclusions can be drawn from the data.

Where appropriate, the symbol # was used to indicate the number of responses received from the training provider group--either joint apprenticeship program, nonjoint apprenticeship program, vo-tech job prep program or the total number of responses to the individual question. The symbol % was used to indicate the percentage of responses received from the training provider group. In some instances, the % column totals may add to greater than 100% since the respondents had the opportunity to choose more than one category.

Question #1: How is the training program administered?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		State-Wide Totals	
	#	%	#	%	#	%	Total #	% of Total
State wide number of training providers	58	100	39	100	64	100	161	100
Number of survey respondents	19	32	24	62	18	28	61	38
Number of surveys returned as undeliverable	3	5	5	13	*	*	8	5
Number of duplicate programs omitted from sample population	*	*	*	*	3	5	3	2
Number of Surveys returned after the cutoff date	*	*	*	*	2	3	2	1

The overall response rate to the survey instrument from all the verifiable construction craft training providers was 38%.

Question #2: Where is the program presented?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Apprenticeship training facility	14	74	2	8	*	*	16	26
Local community college	*	*	9	33	3	17	12	20
Contractor facilities	*	*	4	17	*	*	4	7
Vo-tech education center	4	21	12	50	15	83	31	51
Local High School	2	10	6	25	1	6	9	15
Other	*	*	1	4	*	*	1	2

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

This question identified the type of facilities utilized by craft training providers. joint apprenticeship training providers relied primarily on private apprenticeship training facilities while nonjoint apprenticeship training providers relied primarily on public facilities for apprenticeship training.

Question #3: How many hours per week are the students exposed to classroom training?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Classroom training hours (mean)	5.7	5.7	20.2	10.1

The statistical analysis of variance of the responses to this question indicates there is no significant difference in the number of classroom hours the student is exposed to between the joint and nonjoint (χ^2=0.8575) programs. There is, however, a significant difference between the number of classroom hours the student is exposed to in the vo-tech programs and both the joint (χ^2=0.0001) and nonjoint (χ^2=0.0001) programs. This revelation is not surprising since these vo-tech programs are, primarily, academically orientated.

Question #4: How many hours per week are the students exposed to supervised on-the-job training?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Supervised on-the-job training hours (mean)	40.0	36.4	11.1	29.8

The statistical analysis of variance of the responses to this question indicates there is a significant difference in the number of supervised on-the-job training hours the student is exposed to between the joint and nonjoint (χ^2=0.0289) programs. There is also a significant difference in the number of supervised on-the-job training hours the student is exposed to between the vo-tech programs and both the joint (χ^2=0.0001) and nonjoint (χ^2=0.0001) programs. This difference in supervised on-the-job training hours between the vo-tech and both the joint and nonjoint programs is not surprising since these vo-tech programs are primarily academically orientated. The difference in supervised on-the-job training hours between joint and nonjoint programs is an unexpected revelation and can be attributed to the prohibition in the joint programs of apprentices working unsupervised while nonjoint programs do allow apprentices to work unsupervised.

Question #5: Who teaches the related course instruction in these programs? (check all that apply)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Journeymen	18	95	16	67	*	*	34	56
Contractors	3	17	11	16	*	*	14	23
Manufacturers &/or Suppliers	*	*	3	13	*	*	3	5
Educators	2	11	7	29	*	*	9	15
Local Building Inspectors	*	*	5	21	*	*	5	8
Others	*	*	3	13	*	*	3	5

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

The responses to this question suggest that joint apprenticeship training programs rely heavily upon journeyman craft workers and that nonjoint apprenticeship training programs utilize a broader base of industry professionals to provide craft instruction.

Question #6: Who supervises the apprentice's on-the-job instruction? (check all that apply)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Journeymen	19	100	15	79	3	17	41	67
Contractors	5	26	15	62	7	39	27	44
Apprentice Instructors	3	16	4	17	2	11	9	15
Educators	1	5	1	4	9	50	11	18
Local Building Inspectors	*	*	*	*	*	*	*	*
Others	1	5	4	17	1	6	6	10

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose to more than one category.

The responses to this question suggest that both journeyman craft workers and contractors share the primary responsibility for supervising the apprentice's on-the-job training in the formal apprenticeship programs while educators shoulder this responsibility in the vo-tech programs.

Question #7: What are the required instructor qualifications? (check all that apply)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Journeyman's License in the particular trade	12	50	12	50	2	11	26	43
Completion of an apprenticeship program & 2 years experience	10	53	7	29	2	11	19	31
Craft experience not at the Journeyman level	*	*	*	*	3	17	3	5
2 year college degree	*	*	1	4	5	28	5	10
4 year college degree	*	*	*	*	5	28	5	8
Teaching certification	18	95	16	67	15	83	49	80
Other	8	42	13	54	7	39	28	46

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

In the "Other" category, craft experience in excess of 6 years and committee approval were cited by the joint and nonjoint programs and meeting the Department of Education guidelines and licensed contractor were cited by the vo-tech programs. This question reveals that journeyman licensing, completion of a formal apprenticeship, and teaching certification are the most prevalent requirements for apprentice instructors. It should be noted that "teaching certification" means different things to each of these groups. For the joint and nonjoint programs teaching certification is, typically, the completion of an instructor training program offered by a national trade organization, while for the vo-tech programs teaching certification means meeting the Department of Education guidelines.

Question #8: Who provides your instructor continuing vocational education/training programs? (check all that apply)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
AFL-CIO	17	89	*	4	1	6	18	30
ABC	*	*	4	17	1	6	4	7
Manufacturers &/or suppliers	3	16	9	38	10	56	22	36
AGC	1	5	2	8	1	6	4	7
NAHB	*	*	2	8	*	*	2	3
None	*	*	6	8	2	11	8	13
Others	2	11	10	42	12	67	24	39

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

In the "Other" category, national trade organizations and the Florida university system were cited by all the programs.

Question #9: How often does this program require the instructor's participation in continuing education programs?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Every year	11	58	4	17	5	28	20	33
Every 2 years	*	4	1	4	*	*	*	2
Every 3 years	*	*	1	4	*	6	2	3
Every 4 years	*	*	*	*	*	*	*	*
None	5	26	11	46	2	11	18	30
Other	3	16	3	13	10	56	16	26

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

In the "Other" category, meeting the Department of Education continuing education requirements and "recommended but not required" were cited by the programs. The responses to this question indicate that joint programs require apprentice instructor participation in continuing education more frequently than either the nonjoint or the vo-tech programs.

Question #10: Should craft training instructors be certified as instructors in the particular craft?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Strongly Agree	16	84	22	92	13	72	51	84
Moderately Agree	1	5	*	*	1	6	2	3
Moderately Disagree	*	*	*	*	1	6	1	2
Strongly Disagree	*	*	1	4	1	6	2	3

These craft training providers strongly believe that certification of instructors should be required.

Question #11: What is the maximum yearly training capacity of this program?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Maximum yearly training capacity (mean)	25.4	22.9	16.2	24.0

The statistical analysis of variance of the responses to this question indicates there is no significant difference in the maximum yearly training capacity of the various programs (χ^2=0.3254). The responses to this question indicate that a class size of 20 to 25 students is typical for the existing training infrastructure.

Question #12: What qualifications must the students have to participate? (check all that apply)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Minimum 16 years of age	1	5	7	29	*	*	8	13
High School diploma or equivalent	16	84	16	67	*	*	32	53
Minimum score on aptitude tests	12	63	12	50	*	*	24	39
High School algebra	4	21	2	8	*	*	8	10
Prior trade experience	*	*	2	8	*	*	2	3
Other	13	68	10	42	*	*	23	38

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

The "Other" category of this question included a minimum of 18 years of age for both the joint and nonjoint programs, often citing workman's compensation law requirements. It should be noted that compliance with Florida's child labor laws is also a hinderance when admitting youths younger than 18 into apprenticeship programs.

Question #13: How are the students identified and selected for these programs? (check all that apply)

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	*	%	Total #	% of Total
Local advertisements	18	58	17	79	*	*	39	57
Contractor recommendations	18	53	23	58	*	*	39	64
Other student recommendations	16	84	12	50	*	*	28	46
Military Transition Service Centers	5	26	4	17	*	*	9	15
High School recruiting program	14	84	14	58	*	*	28	46
Other	5	26	7	29	*	*	12	20

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

The "Other" category of this question included the Florida Job Service for both joint and nonjoint Programs. The responses to this question indicate that Military Transition Service Centers are the least utilized resource for attracting new recruits to apprenticeship programs.

Question #14: What is the estimated program completion (graduation) rate?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Program completion rate (mean)	63.6%	51.1%	52.9%	54.4%

The statistical analysis of variance of the responses to this question indicates there is no significant difference in the program completion (graduation) rates between the various programs (χ^2=0.2678). A statistical analysis of the completion rates, by craft, was also performed and found no significant differences between the craft completion rates (χ^2=0.7020). The responses to this question indicate that

approximately 4 of every 10 new apprentices who enter the industry drop out of the training programs prior to completing the training program.

Question #15: When does the highest rate of student dropout occur?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Student dropout timing (mean # of months)	7.7	9.3	7.3	8.3

The statistical analysis of variance of the responses to this question indicates there is no significant difference in the dropout rate between the various programs (χ^2=0.1385). The responses to this question indicate that most students drop out of the training programs within the first year. This suggests a lack of understanding of the realities of the construction industry by individuals entering apprenticeship programs.

Question #16: Do you feel a one-year preapprenticeship program would help reduce the dropout rate?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Strongly agree	4	21	11	46	2	11	11	28
Moderately agree	8	42	9	38	10	56	27	44
Moderately disagree	4	21	2	8	4	22	10	16
Strongly disagree	3	16	2	8	2	11	7	12

The responses to this question indicate there is a belief that some form of industry awareness program, pre-apprenticeship in this instance, would help reduce the training dropout rate.

Question #17: What is the approximate square footage devoted to construction craft training?

1. Classroom instruction.
2. Shop instruction.
3. Administrative functions.

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Classroom instruction (mean)	4,456	1,230	1,610	3,040
Shop instruction (mean)	6,302	2,634	7,030	5,120
Administrative functions (mean)	883	1,037	515	860

The responses to this question indicate the mean size of training facilities currently utilized to provide construction craft training.

Question #18: Are the classroom facilities adequate?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Fully adequate	15	79	10	42	10	56	35	57
Moderately adequate	4	21	12	50	5	28	21	34
Moderately inadequate	*	*	1	4	3	17	4	7
Completely inadequate	*	*	*	*	*	*	*	*

The responses to this question indicates the current classroom facilities utilized for construction craft training are considered adequate for the existing training levels.

Question #19: Are the shop facilities adequate?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Fully adequate	14	74	7	29	8	44	29	48
Moderately adequate	4	21	13	54	5	28	22	36
Moderately inadequate	1	5	3	13	5	28	9	15
Completely inadequate	*	*	1	4	*	*	1	2

The responses to this question indicates the current shop facilities utilized for construction craft training are considered adequate for the existing training levels.

Question #20: Are the administrative facilities adequate?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	4	%	#	%	#	%	Total #	% of Total
Fully adequate	14	90	15	63	10	56	42	69
Moderately adequate	2	11	7	29	4	22	13	21
Moderately inadequate	*	*	1	4	2	11	3	5
Completely inadequate	*	*	*	*	1	6	1	2

The responses to this question indicates the current administrative facilities utilized for construction craft training are considered adequate for the existing training levels.

Question #21

The data on the following three pages were developed through research at the Florida Departments of Labor and Education, not from responses to the survey instrument. The enrollment information on the next page is the number of apprentices enrolled in both joint and nonjoint *registered* apprenticeship programs as of December 1992 and the number of students enrolled in vo-tech job preparation programs as of the fiscal year 91-92 reporting period. The information on the following pages show the average level of apprentice completions for each of the identified crafts, the projected annual number of craft openings and the percentage of craft openings currently being filled by apprenticeship completers. The projected number of craft openings information was developed by the Florida Department of Labor and Employment Security, Bureau of Labor Market Information, and published in the *Florida Industry and Occupational Employment Projections 1990 - 2005,* October 1992 issue.

What is the current student enrollment in each training program offered?

1. Boilermaker
   - 0 Joint
   - 0 Nonjoint
   - 0 Vo-tech
   - 0 Total
2. Brick Mason & Stone Mason
   - 38 Joint
   - 5 Nonjoint
   - 214 Vo-tech
   - 257 Total
3. Carpenter
   - 259 Joint
   - 31 Nonjoint
   - 594 Vo-tech
   - 884 Total
4. Cement & Terrazzo Finisher
   - 0 Joint
   - 0 Nonjoint
   - 0 Vo-tech
   - 0 Total
5. Electrician
   - 474 Joint
   - 933 Nonjoint
   - 837 Vo-tech
   - 2,244 Total
6. Elevator Constructor
   - 0 Joint
   - 8 Nonjoint
   - 0 Vo-tech
   - 8 Total
7. Equipment Operator
   - 17 Joint
   - 0 Nonjoint
   - 0 Vo-tech
   - 17 Total
8. Insulator
   - 67 Joint
   - 0 Nonjoint
   - 0 Vo-tech
   - 67 Total
9. Ironworker
   - 140 Joint
   - 0 Nonjoint
   - 3 Vo-tech
   - 143 Total
10. Millwright
    - 33 Joint
    - 0 Nonjoint
    - 0 Vo-tech
    - 33 Total
11. Painter
    - 60 Joint
    - 6 Nonjoint
    - 0 Vo-tech
    - 66 Total
12. Plasterer, Lather & Drywall Finisher
    - 7 Joint
    - 0 Nonjoint
    - 21 Vo-tech
    - 28 Total
13. Plumber
    - 209 Joint
    - 238 Nonjoint
    - 311 Vo-tech
    - 758 Total
14. Pipe Fitter
    - 189 Joint
    - 2 Nonjoint
    - 0 Vo-tech
    - 191 Total
15. Sprinkler Fitter
    - 41 Joint
    - 106 Nonjoint
    - 7 Vo-tech
    - 154 Total
16. Roofer
    - 50 Joint
    - 0 Nonjoint
    - 0 Vo-tech
    - 50 Total
17. Sheet Metal Worker
    - 186 Joint
    - 110 Nonjoint
    - 13 Vo-tech
    - 309 Total
18. Refrigeration Mechanic
    - 14 Joint
    - 201 Nonjoint
    - 3059 Vo-tech
    - 3,274 Total
19. Tile Setter & Marble Finisher
    - 6 Joint
    - 29 Nonjoint
    - 31 Vo-tech
    - 66 Total
20. Other (Glazier)
    - 2 Joint
    - 2 Nonjoint
    - 1 Vo-tech
    - 5 Total

Craft	Training Sponsor	Registered Apprenticeship Training Programs, State-Wide Total	Annual Average Number of Apprentice Completions	Projected Annual Number of Craft Openings	Percent of Annual Craft Openings Filled by Apprenticeship
Electrician	Nonjoint Joint Total	21 11 32	233 95 328	Growth 664 Depart. 648 Total 1,312	25%
Plumber	Nonjoint Joint Total	16 9 25	60 42 102	Growth 481 Depart. 478 Total 959	19%
Pipe Fitter	Nonjoint Joint Total	3 10 13	1 38 39	w /Plumber	w/Plumber
Sprinkler Fitter	Nonjoint Joint Total	6 1 7	35 8 43	w/Plumber	w/Plumber
Carpenter	Nonjoint Joint Total	10 6 16	8 65 73	Growth 975 Depart. 1,068 Total 2,043	4%
Millwright	Nonjoint Joint Total	0 5 5	0 8 8	Growth 22 Depart. 37 Total 59	14%
Flooring Installer	Nonjoint Joint Total	0 0 0	0 0 0	Growth 45 Depart. 43 Total 88	0%
Drywall Finisher	Nonjoint Joint Total	1 1 2	0 8 8	Growth 103 Depart. 154 Total 257	1%
Lather	Nonjoint Joint Total	0 1 1	0 0 0	Growth 8 Depart. 13 Total 21	4%
Plasterer	Nonjoint Joint Total	[illegible] [illegible] [illegible]	0 0 0	Growth 38 Depart. 102 Total 140	0%
Refrigeration Mechanic &/or HVAC Installer	Nonjoint Joint Total	11 2 13	67 4 71	Growth 371 Depart. 236 Total 607	12%
Sheet Metal Duct Installer	Nonjoint Joint Total	11 4 15	26 47 73	Growth 41 Depart. 49 Total 90	81%
Painter	Nonjoint Joint Total	2 4 6	2 20 22	Growth 645 Depart. 569 Total 1,214	2%

Craft	Training Sponsor	Registered Apprenticeship Training Programs, State Wide Total	Annual Average # of Apprentice Completions	Projected Annual Number of Craft Openings	Percent of Annual Craft Openings Filled by Apprenticeship
Ironworker	Nonjoint Joint Total	1 6 7	0 47 47	Growth 70 Depart. 105 Total 175	27%
Roofer	Nonjoint Joint Total	0 2 2	0 17 17	Growth 207 Depart. 142 Total 349	6%
Equipment Operator	Nonjoint Joint Total	1 5 6	0 6 6	Growth 98 Depart. 96 Total 194	3%
Tile Setter	Nonjoint Joint Total	1 2 3	10 2 12	Growth 29 Depart. 48 Total 77	16%
Glazier	Nonjoint Joint Total	2 2 4	0 0 0	Growth 63 Depart. 76 Total 139	1%
Asbestos Worker/ Insulator	Nonjoint Joint Total	1 3 4	0 17 17	Growth 45 Depart. 152 Total 197	9%
Elevator Constructor	Nonjoint Joint Total	1 0 1	2 0 2	Growth 8 Depart. 13 Total 21	10%
Stone Mason	Nonjoint Joint Total	0 3 3	0 0 0	Growth 5 Depart. 9 Total 14	6%
Brick Mason	Nonjoint Joint Total	2 3 5	2 13 15	Growth 96 Depart. 147 Total 243	6%
Concrete & Terrazzo Finisher	Nonjoint Joint Total	1 1 2	0 0 0	Growth 126 Depart. 336 Total 462	0%
Boilermaker	Nonjoint Joint Total	0 0 0	0 0 0	Growth 6 Depart. 11 Total 17	0%
Other Trades				Growth 239 Depart. 138 Total 377	
Totals	Nonjoint Joint Total	92 83 175	447 432 879	Growth 4,385 Depart. 4,670 Total 9,055	10%

The data presented on the previous three pages indicate that for virtually every craft within the industry, the current level of craft apprenticeship training and vo-tech job prep training in Florida is clearly insufficient to meet the manpower needs of the Florida construction industry. Industry wide, the average level of apprenticeship completions is 879 completions per year while the industry separations average 4,670 per year.

Question #22: Does this training program have a permanent or part-time office and administrative staff?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Permanent	19	100	14	58	14	78	47	77
Part-time	1	5	10	42	3	17	14	23

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

The responses to this question indicates that most training programs have a permanent administrative staff.

Question #23: Please identify the number of staff personnel.

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Administrative (mean)	1.8	1.8	1.6	1.7
Technical and/or instructors (mean)	4.6	8.8	4.4	6.1
Secretarial (mean)	1.0	1.0	2.9	1.5
Other (mean)	3.5	1.4	1.0	3

The responses to this question indicates the mean size of the training program staff.

Question #24 Please identify the number of staff personnel who report to

1. The apprenticeship committee.

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Administrative (mean)	1.3	1.4	1.3	1.4
Technical and/or instructors (mean)	1.3	7.9	8	7.0
Secretarial (mean)	1.0	0.9	0	0.9
Other (mean)	0	2.6	4.5	2.7

The responses to this question indicates the mean size of the training program staff who report to the apprenticeship committee.

2. The local education agency.

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Administrative (mean)	1.4	1.3	1.3	7.0
Technical and/or instructors (mean)	1.3	6.6	5.4	5.5
Secretarial (mean)	0	0.9	1.5	1.1
Other (mean)	0	1.3	8	2.4

The responses to this question indicates the mean size of the training program staff who report to the local education agency.

Question #25: Does this program receive grant funding from

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	*	%	#	%	1	%	Total #	% of Total
Industry Monetary Grants	*	5	1	4	*	*	2	3
Industry Equipment Grants	*	*	1	4	*	6	2	3
Public Education Funding	9	47	6	37	*	*	17	42
Federal Education Funding	*	*	*	*	9	50	9	50
Employer Assessments	10	53	6	25	1	6	17	28
JTPA Funds	1	5	2	8	8	44	11	18
Other	*	*	*	*	*	*	*	*

Note: Column totals may add to more than 100% since the respondents had the opportunity to choose more than one category.

The responses to this question indicates the major sources of funding for these training programs are employers and both the state and federal governments.

Question #26: Please identify the funding agency, the funding amount and the funding duration.

The response to this question was insufficient to draw any conclusions.

Question #27: Please identify any specific funding criteria.

The response to this question was insufficient to draw any conclusions.

Question #28: What is the approximate yearly budget for this training program?

The response to this question was insufficient to draw any conclusions; however, the few complete responses that were received suggested a yearly training budget of approximately $1700 per student.

Question #29: What is the annual cost to the student?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Student Cost (mean)	$67.86	$66.42	$505.07	**$219.91**

The statistical analyses of variance of the responses to this question indicates there is no significant difference in the cost to the student between the joint and nonjoint (χ^2=0.8896) programs and there is a significant difference in the cost to the student between the vo-tech programs and the joint (χ^2=0.0001) and nonjoint (χ^2=0.0002) programs. The responses to this question indicate the cost to the student is higher in the vo-tech programs than in the joint or nonjoint programs. The annual cost to the student in both the joint and nonjoint programs was typically identified as the costs for text books.

Question #30: What is the annual cost, per student, to the contractor?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Contractor cost (mean)	$/hour assessment	$313.68	$301.67	**$312.05**

The statistical analysis of variance of the responses to this question indicates there is no significant difference in the cost per student to the contractor between the nonjoint and the vo-tech programs (χ^2=0.9999). The contractor cost for the joint programs is directly dependent upon the craft hours worked and is, therefore, variable from year to year and from contractor to contractor.

Question #31: What is the annual cost per student, if any, to the public education finance committee?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Public education finance committee cost (mean)	$3176.57	$3912.00	$3884.42	$3788.70

The statistical analysis of variance of the responses to this question indicates there is no significant difference in the cost to the public education finance committee among the various programs (χ^2=0.1159). Is should be noted that 7 of the 19 joint programs (37%) and 20 of the 24 nonjoint programs (83%) report receiving public funding.

Question #32: What is this program's estimated expenditure to educate each student per year?

	Joint Apprenticeship Programs	Nonjoint Apprenticeship Programs	Vo-tech Job Preparation Programs	Training Provider Mean
Program annual expenditure (mean)	$2381.21	$992.92	$3072.00	$1990.13

The statistical analysis of variance of the responses to this question indicates there is no significant difference in the program expenditures between the joint and vo-tech (χ^2=0.0904) programs, but there is a significant difference in the program expenditures between the nonjoint and the joint (χ^2=0.0236) and vo-tech (χ^2=0.0316) programs. The responses to this question indicate the nonjoint programs devote fewer monetary resources to craft training than do the other programs.

Question #33: Is the construction industry providing enough craft training?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Fully adequate	4	21	2	8	1	6	7	11
Moderately adequate	[illegible]	42	7	29	5	28	20	33
Moderately inadequate	2	11	6	25	6	33	14	23
Completely inadequate	4	21	9	38	4	22	17	28

The responses to this question indicate the joint apprenticeship training providers feel the construction industry is providing adequate levels of training while the nonjoint and vo-tech programs feel the industry is providing inadequate levels of training.

Question #34: Does the location of your training program meet the student needs?

	Joint Apprenticeship Programs		Nonjoint Apprenticeship Programs		Vo-tech Job Preparation Programs		Question Totals	
	#	%	#	%	#	%	Total #	% of Total
Fully adequate	14	74	11	46	11	61	36	59
Moderately adequate	#	21	13	54	7	39	24	39
Moderately inadequate	*	*	*	*	*	*	*	*
Completely inadequate	*	*	*	*	*	*	*	*

The responses to this question indicates the current location of the facilities are adequate to meet the needs of the students.

Question #35: As a construction craft training provider, what is your primary need?

The following quoted responses from the survey instrument were typical.

"A much better quality of applicant, especially those seeking a career who have just graduated. The public school system is producing graduates that have very poor basic skills making it necessary for us to spend too much time remediating that applicant, using up valuable training time."

"Public recognition of the value of an adequate supply of highly trained craftsmen and the recognition that support of craft training is in the public's interest."

"Our primary need is for the academic faculty, advisors [and] administrators of the public schools to realize the need for quality vocational programs and career counseling in the high schools. The construction industry has historically been the "dumping grounds" for the students who are not considered to be college oriented. Today's technology demands workers who are prepared well in Math, English and the work ethics necessary to succeed in this demanding industry."

"To educate the industry why there is a need for this training."

Question #36: What are the biggest problems associated with providing construction craft training?

The following quoted responses from the survey instrument were typical.

"[The] on again - off again [nature of] employment due to finishing one job and the start of another. The ongoing safety problems that are associated with the construction industry."

"High School graduates that can neither read or write. Training people with these problems is almost impossible because they can't comprehend the training materials."

"... companies have become increasingly specialized. There are few construction companies (general contractors) who hire their own crews. Work is usually "subbed out", so it is difficult to get well-rounded training in some crafts, such as carpentry which is now very specialized. Additionally workers in hard construction jobs are not overly interested in going to school in the evenings after putting in a hot, physical day."

"Many of the students lack the basic knowledge in Math and English. We spend extra hours to upgrade their math skills to an adequate level."

Question #37: What is your recommended solution to solving these training problems

The following quoted responses from the survey instrument were typical.

"Reaching students at a younger age level, high school is to late."

"Work with employers to ensure good training is done. Make them more a part of the training system."

"Allow more high schools to be tech prep orientated to allow career paths towards the construction industry."

"The construction industry has a very bad reputation. The industry must change the perception that the profit motive is the bottom line and that the craft workers are expendable."

"More emphasis on career choices needs to be provided in the junior high and high schools. Vocational education programs should be promoted in a positive way by professional educators. High school pre-apprenticeship programs could be developed."

Question #38: Do you have any further comments you would like to share?

The following quoted responses from the survey instrument were typical.

"In the last ten years the quality of the construction work force has been alarmingly diminished. [Hurricane] "Andrew" is proof positive of the economic impact of faulty construction performed by incompetent workers. The cost of permitting a decline in training is to be borne by the citizens through higher insurance rates."

"Apprenticeship has proven to be a very effective means of developing a strong work force. It should be promoted strongly by the educational community and the government as a good alternative to a college education."

"Craft training has suffered a decline over the past couple of decades because of the emphasis on a college education as the only way to succeed in life.... As a result, many of those gravitating to the trades are not second, third or fourth

generation craftsmen as in the past, but those who were unable to "cut the mustard" in other career ventures."

"We are happy to correspond with any educational institutions who are improving the construction training in Florida. Please notify us if there is any way that we can help."

Summary of the construction industry training provider follow-up survey

Each of the respondents to the initial survey instrument were given the opportunity to request a summary copy of the survey instrument results. Sixty of the training providers requested a summary copy of the results. The researcher included an additional survey instrument designed to test the training provider's opinions concerning the following proposed recommendations. It should be noted that statistically valid conclusions concerning the opinions of the entire training provider population cannot be drawn from the results of this follow-up survey.

Should "career awareness" programs be initiated in Florida's middle schools?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
23	85	4	15	0	0	0	0

Should "school-to-work" transition and/or "youth apprenticeship" programs be introduced in Florida's high schools?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
20	74	4	15	1	4	2	7

Should postsecondary construction craft training providers develop stronger contractor ties?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
20	74	4	15	2	7	1	4

Should apprenticeship training providers contract with postsecondary institutions, to provide the academic related training, where ever practical.

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
15	56	9	33	1	4	2	7

Should "standard skill certification" be required of all apprenticeship graduates?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
20	74	5	19	2	7	0	0

Should "standard skill certification" be required of all vo-tech job prep graduates?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
18	67	9	33	0	0	0	0

Should construction craft instructors be required to complete 6 construction and/or craft related continuing education units every 2 years?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
10	37	10	37	5	19	2	7

Should the State of Florida provide tax incentives to contractors who establish and maintain registered apprenticeship training programs?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
18	67	7	36	0	0	2	7

Should the State of Florida mandate journeyman certification in all crafts?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
16	59	9	33	1	4	1	4

Should the State of Florida mandate craft journeyman levels on all job sites?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
12	45	10	37	3	11	2	7

Should local governmental agencies mandate craft journeyman levels on all job sites?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
11	41	10	37	3	11	3	11

Should the State of Florida mandate craft apprentice levels on state funded construction projects?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
14	51	8	31	2	7	3	11

The current number of apprenticeship graduates presently fills approximately 10% of the construction industry's annual need for craft workers. Should the State of Florida attempt to increase the annual number of apprenticeship graduates from the current level of 879 per year to 2,700 per year within 5 years?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
14	51	7	26	1	4	5	19

The State of Florida is currently providing approximately $20 million per year to fund construction craft apprenticeship training, approximately $5,100 per enrolled apprentice per year. Should the Department of Education make additional funds available to increase the number of apprenticeship graduates?

Strongly Agree		Moderately Agree		Moderately Disagree		Strongly Disagree	
#	%	#	%	#	%	#	%
17	62	4	15	1	4	5	19

The responses to the follow-up survey indicate a strong to moderate agreement from the training providers to each of the proposed recommendations.

APPENDIX B

CRAFT TRAINING MODEL SIMULATION RESULTS

This appendix includes the construction craft training model simulation results. A graphical representation of the model is included for simplicity. Graphical representations of the equations and the labor pool results follow. The numerical printouts for each of the equations is included. Finally a narrative description of each of the initial labor pool values, and the development process for each of the individual rate equations that were used in the program

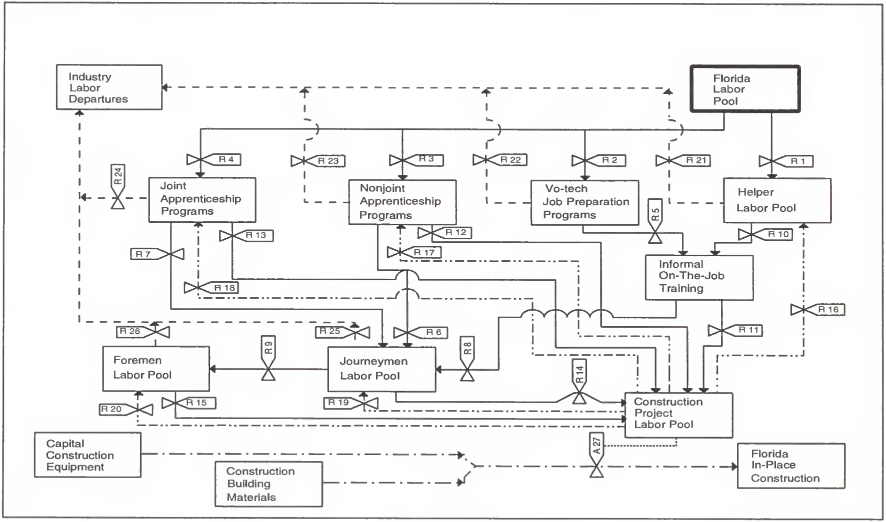
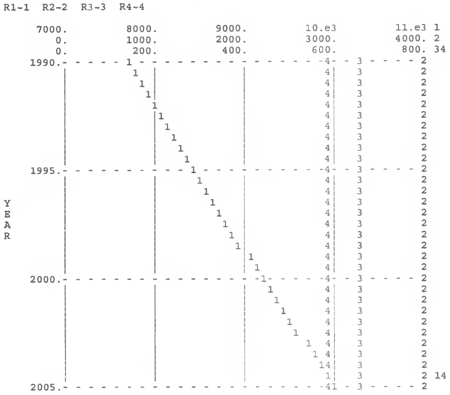


Figure B-1 Construction industry craft training model

Helper, Vo-tech, Nonjoint & Joint Rate Equations

This graph shows the annual demand for unskilled workers entering the industry. The premise of this simulation is to determine what will happen to the work force if there are no increases in construction craft training levels. Rate equation R1 shows all the industry growth going through the Helper route of no formal craft training. Rate equations R2 (vo-tech job prep), R3 (nonjoint apprenticeship) and R4 (joint apprenticeship) are held flat for the simulation duration.

Table C-1 Graphic representation of the helper, vo-tech, nonjoint and joint rate equation calculations from 1990 to 2005



Vo-tech Graduation and Apprenticeship Completion Rate Equations

This graph shows that vo-tech job prep graduations (R5), nonjoint apprenticeship completions (R6) and joint apprenticeship completions (R7) are held flat during the 15 year calculation period.

Table C-2 Graphic representation of the vo-tech graduation and apprenticeship completion rate equations from 1990 to 2005

```
R5~1  R6~2  R7~3

        0.              500.              1000.             1500.             2000. 1
        0.              200.               400.              600.              800. 23
    1990.- - - - - - - - - - - - - - - - - - 12- - - - - - - - - - - - - - - - - 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
    1995.- - - - - - - - - - - - - - - - - - 12- - - - - - - - - - - - - - - - - 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
Y        |                |                | 12              |                | 13
E        |                |                | 12              |                | 13
A        |                |                | 12              |                | 13
R        |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
    2000.- - - - - - - - - - - - - - - - - - 12- - - - - - - - - - - - - - - - - 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
         |                |                | 12              |                | 13
    2005.- - - - - - - - - - - - - - - - - - 12- - - - - - - - - - - - - - - - - 13
```

Skilled Labor Requirement Rate Equations

This graph shows the increasing, annual, demand for skilled labor during the calculation period. The annual demand for journeyman level craft workers (R8) steadily and uniformly increases from 4,870 individuals in 1990, to 6,315 individuals in 2005. The annual demand for foremen level craft workers (R9) steadily and uniformly increases from 1560 individuals in 1990, to 2007 individuals in 2005.

Table C-3 Graphic representation of the skilled labor requirement rate equations from 1990 to 2005

```
R8~1  R9~2

     4500.         5000.         5500.         6000.         6500. 1
     1400.         1600.         1800.         2000.         2200. 2
    1990.- - - - - 12- - - - - - - - - - - - - - - - - - - - - - -
         |          12 |             |             |             |
         |           12|             |             |             |
         |             1             |             |             |   12
         |             |1            |             |             |   12
         |             | 1           |             |             |   12
         |             | 21          |             |             |
         |             |  2 1        |             |             |
         |             |   2 1       |             |             |
         |             |    2 1      |             |             |
    1995.- - - - - - - - - - -2-1- - - - - - - - - - - - - - - - -
         |             |      2 1    |             |             |
         |             |       2 1   |             |             |
Y        |             |        2  1|             |             |
E        |             |         2  1             |             |
A        |             |          2 |1            |             |
R        |             |           2|  1          |             |
         |             |             2   1         |             |
         |             |             |2   1        |             |
         |             |             | 2    1      |             |
    2000.- - - - - - - - - - - - - - - -2- - 1 - - - - - - - - - -
         |             |             |   2    1    |             |
         |             |             |    2    1   |             |
         |             |             |     2    1  |             |
         |             |             |      2      1             |
         |             |             |       2     |1            |
         |             |             |         2   |  1          |
         |             |             |          2  |   1         |
         |             |             |           2 |     1       |
         |             |             |            2|      1      |
    2005.- - - - - - - - - - - - - - - - - - - - - 2 - - - 1 - - -
```

Projected Labor Demand Rate Equations

This is another graph showing the increasing demand for skilled labor (foremen {R9} and journeymen {R8}) and unskilled labor (helpers {R10}) during the 15 year calculation period. This graph is presented to show that the model has uniform and steady growth in the demand for construction craft labor. This graph was utilized to detect for inaccurate equations in the model.

Table C-4 Graphic representation of the projected labor demand rate equations from 1990 to 2005

```
R8~1  R9~2  R10~3

     4500.         5000.         5500.         6000.         6500. 1
     1400.         1600.         1800.         2000.         2200. 2
     70.e3         80.e3         90.e3        100.e3        110.e3 3
     1990.- - - - - 12- - - - - - - - - - - - - - - - - - - - - - 13
          |         12  |            |             |             | 13
          |           12|            |             |             | 13
          |           31             |             |             | 12
          |            31            |             |             | 12
          |             |31          |             |             | 12
          |             | 21         |             |             | 23
          |             | 2 1        |             |             | 23
          |             |  2 1       |             |             | 23
          |             |   2 1      |             |             | 23
     1995.- - - - - - - - -  32-1- - - - - - - - - - - - - - - - -
          |             |     32 1   |             |             |
          |             |      32 1  |             |             |
Y         |             |       32  1|             |             |
E         |             |        32  1             |             |
A         |             |         32 |1            |             |
R         |             |          32| 1           |             |
          |             |            2   1         |             | 23
          |             |            |2   1        |             | 23
          |             |            | 2    1      |             | 23
     2000.- - - - - - - - - - - - - - -2- - 1 - - - - - - - - - - 23
          |             |            |   2     1   |             | 23
          |             |            |    2     1  |             | 23
          |             |            |     2     1 |             | 23
          |             |            |      2      1             | 23
          |             |            |       2     |1            | 23
          |             |            |         2   |  1          | 23
          |             |            |          2  |   1         | 23
          |             |            |           2 |     1       | 23
          |             |            |            2|      1      | 23
     2005.- - - - - - - - - - - - - - - - - - - - -2 - - - 1 - - - 23
```

Projected Construction Project Labor Rate Equations

This graph shows the projected demand for construction craft labor from each of the primary labor pools: Informal on-the-job training (R11), nonjoint apprenticeship programs (R12), joint apprenticeship programs (R13), journeymen labor pool (R14) and foremen labor pool (R15). This graph was utilized to verify that the construction craft labor requirement equations exhibited either a uniform and steady growth, or the forced flatness, in each of the previously identified labor pools.

Table C-5 Graphic representation of the projected construction project labor rate equations from 1990 to 2005

```
R11~1  R12~2  R13~3  R14~4  R15~5

     60.e3         70.e3         80.e3         90.e3        100.e3 1
        0.          500.         1000.         1500.         2000. 23
    110.e3        120.e3        130.e3        140.e3        150.e3 4
     40.e3         45.e3         50.e3         55.e3         60.e3 5
    1990.4 -5- - - - - - -1- - - - - - - 2 - - 3 - - - - - - - - - -
         |4  5         |   1         |   2     3   |             |
         | 4  5        |   1         |   2     3   |             |
         |   4 5       |    1        |   2     3   |             |
         |    4 5      |     1       |   2     3   |             |
         |     4 5     |      1      |   2     3   |             |
         |       45    |       1     |   2     3   |             |
         |        45   |        1    |   2     3   |             |
         |          4  |         1   |   2     3   |             | 45
         |           4 |          1  |   2     3   |             | 45
    1995.- - - - - - -54 - - - - - 1 - - 2 - - 3 - - - - - - - - - -
         |             54           1|   2     3   |             |
         |             | 4           1   2     3   |             | 45
Y        |             |   54        |1  2     3   |             |
E        |             |    54       | 1 2     3   |             |
A        |             |     5 4     |  12     3   |             |
R        |             |      5 4    |   1     3   |             | 12
         |             |       5  4  |   21    3   |             |
         |             |        5  4 |   2 1   3   |             |
         |             |          5 4|   2  1  3   |             |
    2000.- - - - - - - - - - - - -5- 4 - 2 - 1 3 - - - - - - - - - -
         |             |           5 | 4 2    13   |             |
         |             |            5|  42     1   |             | 13
         |             |             |5  24    31  |             |
         |             |             | 5 2 4   3 1 |             |
         |             |             |  52   4 3  1|             |
         |             |             |   2     3   1             | 34,25
         |             |             |   25    34  |1            |
         |             |             |   2  5  3  4| 1           |
         |             |             |   2   5 3   4   1         |
    2005.- - - - - - - - - - - - - - - - 2 - -53 - - 4 -1- - - - -
```

Projected Construction Industry Labor Departure Rate Equations

This graph shows the projected construction craft labor departures from each of the primary labor pools: helper labor pool (R21), vo-tech job prep programs (R22) nonjoint apprenticeship programs (R23), joint apprenticeship programs (R24), journeymen labor pool (R25) and foremen labor pool (R26). This graph was utilized to verify that the projected craft labor departure equations exhibited either a uniform and steady growth, or the forced flatness, in each of the previously identified labor pools.

Table C-6 Graphic representation of the projected construction industry labor departure rate equations from 1990 to 2005

```
R21~1  R22~2  R23~3  R24~4  R25~5  R26~6

      1100.         1200.         1300.         1400.         1500. 1
         0.         1000.         2000.         3000.         4000. 2
         0.          100.          200.          300.          400. 3
         0.           50.          100.          150.          200. 4
      2100.         2300.         2500.         2700.         2900. 5
       800.          900.         1000.         1100.         1200. 6
     1990.16- -5- - - - - - - - - - - - 3 - - - - 2 - 4 - - - - - -
          | 1    5      |             | 3         2 | 4           | 16
          |  1    5     |             | 3         2 | 4           | 16
          |   61    5   |             | 3         2 | 4           |
          |     1    5  |             | 3         2 | 4           | 16
          |      61   5 |             | 3         2 | 4           |
          |       61    5             | 3         2 | 4           |
          |        6 1  |5            | 3         2 | 4           |
          |         6 1 | 5           | 3         2 | 4           |
          |          6  1   5         | 3         2 | 4           |
     1995.- - - - - - 6 -1- -5- - - - - 3 - - - - 2 - 4 - - - - - -
          |            6|  1   5      | 3         2 | 4           |
          |             6   1   5     | 3         2 | 4           |
Y         |             |6    1   5   | 3         2 | 4           |
E         |             | 6    1   5  | 3         2 | 4           |
A         |             |   6    1  5 | 3         2 | 4           |
R         |             |    6    1   5 3         2 | 4           |
          |             |     6     1 |53         2 | 4           |
          |             |      6     1| 35        2 | 4           |
          |             |       6     |13 5       2 | 4           |
     2000.- - - - - - - - - - - -6- - - 1 - 5 - - 2 - 4 - - - - - - 13
          |             |          6  | 3 1  5    2 | 4           |
          |             |           6 | 3   1  5  2 | 4           |
          |             |            6| 3    1  5 2 | 4           |
          |             |             6 3      1  2 | 4           | 25
          |             |             |63        12 5 4           |
          |             |             | 36        1 |54           | 12
          |             |             | 3 6       2 1 45          |
          |             |             | 3  6      2 | 1 5         | 14
          |             |             | 3   6     2 | 41  5       |
     2005.- - - - - - - - - - - - - - - 3 - - 6 - 2 - 4 -1-5- - - -
```

Florida Construction Craft Labor Model Simulation, Calculated Equation Values

The figures on the following three pages are the numerical values for each of the rate or level equations at the end of the calculation period. These figures are utilized to verify the expected growth pattern and to allow the researcher to quantify the areas of interest. This table was the primary tool for calculating the expected demand for skilled craft workers during the calculation period.

Table C-7 Calculated equation values for the Florida construction craft labor model simulation from 1990 to 2005

YEAR	1990.	1991.	1992.	1993.	1994.	1995.
R1	7732.7	7874.2	8018.1	8163.7	8311.	8460.
R2	4005.	4005.	4005.	4005.	4005.	4005.
R3	665.73	665.73	665.73	665.73	665.73	665.73
R4	589.18	589.18	589.18	589.18	589.18	589.18
R5	1090.2	1090.2	1090.2	1090.2	1090.2	1090.2
R6	447.07	447.07	447.07	447.07	447.07	447.07
R7	431.9	431.9	431.9	431.9	431.9	431.9
R8	4870.6	4960.2	5050.2	5141.2	5233.3	5326.5
R9	1559.2	1586.7	1614.6	1642.8	1671.3	1700.1
R10	77.4e3	78.81e3	80.25e3	81.71e3	83.19e3	84.68e3
R11	72.2e3	73.52e3	74.86e3	76.21e3	77.57e3	78.95e3
R12	1170.3	1170.3	1170.3	1170.3	1170.3	1170.3
R13	1359.8	1359.8	1359.8	1359.8	1359.8	1359.8
R14	110.1e3	112.e3	114.e3	116.e3	118.e3	120.e3
R15	41.13e3	41.86e3	42.61e3	43.37e3	44.14e3	44.93e3
R16	72.2e3	73.52e3	74.86e3	76.21e3	77.57e3	78.95e3
R17	1170.3	1170.3	1170.3	1170.3	1170.3	1170.3
R18	1359.8	1359.8	1359.8	1359.8	1359.8	1359.8
R19	110.1e3	112.e3	114.e3	116.e3	118.e3	120.e3
R20	41.13e3	41.86e3	42.61e3	43.37e3	44.14e3	44.93e3
R21	1106.9	1127.2	1147.8	1168.6	1189.7	1211.
R22	2914.8	2914.8	2914.8	2914.8	2914.8	2914.8
R23	218.67	218.67	218.67	218.67	218.67	218.67
R24	157.28	157.28	157.28	157.28	157.28	157.28
R25	2185.1	2223.7	2262.8	2302.3	2342.2	2382.6
R26	813.69	828.22	843.	858.03	873.32	888.86
FLAP	1500.e3	1487.e3	1474.e3	1460.e3	1447.e3	1433.e3
HLAP	78.5e3	79.94e3	81.4e3	82.88e3	84.38e3	85.89e3
VTJP	8010.	8010.	8010.	8010.	8010.	8010.
NJAP	1836.	1836.	1836.	1836.	1836.	1836.
JAPP	1949.	1949.	1949.	1949.	1949.	1949.
IOJT	77.07e3	78.48e3	79.91e3	81.35e3	82.81e3	84.28e3
JMLP	113.8e3	115.8e3	117.9e3	119.9e3	122.e3	124.1e3
FMLP	41.94e3	42.69e3	43.45e3	44.23e3	45.02e3	45.82e3
ILDP	0.	7414.8	14.9e3	22.47e3	30.11e3	37.82e3
CPLP	309.4e3	309.4e3	309.4e3	309.4e3	309.4e3	309.4e3
CPLR	225.9e3	229.9e3	234.e3	238.1e3	242.2e3	246.4e3
YEAR	1990.	1991.	1992.	1993.	1994.	1995.

Table C-7--continued

YEAR	1996.	1997.	1998.	1999.	2000.	2001.
R1	8610.7	8763.1	8917.4	9073.4	9231.2	9390.8
R2	4005.	4005.	4005.	4005.	4005.	4005.
R3	665.73	665.73	665.73	665.73	665.73	665.73
R4	589.18	589.18	589.18	589.18	589.18	589.18
R5	1090.2	1090.2	1090.2	1090.2	1090.2	1090.2
R6	447.07	447.07	447.07	447.07	447.07	447.07
R7	431.9	431.9	431.9	431.9	431.9	431.9
R8	5420.8	5516.1	5612.5	5710.1	5808.8	5908.6
R9	1729.3	1758.8	1788.6	1818.8	1849.3	1880.2
R10	86.19e3	87.71e3	89.25e3	90.82e3	92.4e3	93.99e3
R11	80.35e3	81.76e3	83.19e3	84.64e3	86.1e3	87.58e3
R12	1170.3	1170.3	1170.3	1170.3	1170.3	1170.3
R13	1359.8	1359.8	1359.8	1359.8	1359.8	1359.8
R14	122.1e3	124.2e3	126.3e3	128.4e3	130.5e3	132.7e3
R15	45.73e3	46.54e3	47.36e3	48.2e3	49.05e3	49.92e3
R16	80.35e3	81.76e3	83.19e3	84.64e3	86.1e3	87.58e3
R17	1170.3	1170.3	1170.3	1170.3	1170.3	1170.3
R18	1359.8	1359.8	1359.8	1359.8	1359.8	1359.8
R19	122.1e3	124.2e3	126.3e3	128.4e3	130.5e3	132.7e3
R20	45.73e3	46.54e3	47.36e3	48.2e3	49.05e3	49.92e3
R21	1232.6	1254.4	1276.5	1298.8	1321.4	1344.3
R22	2914.8	2914.8	2914.8	2914.8	2914.8	2914.8
R23	218.67	218.67	218.67	218.67	218.67	218.67
R24	157.28	157.28	157.28	157.28	157.28	157.28
R25	2423.5	2464.9	2506.7	2549.	2591.7	2635.
R26	904.67	920.73	937.05	953.64	970.49	987.6
FLAP	1420.e3	1406.e3	1392.e3	1377.e3	1363.e3	1349.e3
HLAP	87.42e3	88.97e3	90.53e3	92.12e3	93.72e3	95.34e3
VTJP	8010.	8010.	8010.	8010.	8010.	8010.
NJAP	1836.	1836.	1836.	1836.	1836.	1836.
JAPP	1949.	1949.	1949.	1949.	1949.	1949.
IOJT	85.77e3	87.28e3	88.81e3	90.35e3	91.91e3	93.49e3
JMLP	126.2e3	128.4e3	130.6e3	132.8e3	135.e3	137.2e3
FMLP	46.63e3	47.46e3	48.3e3	49.16e3	50.03e3	50.91e3
ILDP	45.61e3	53.48e3	61.44e3	69.47e3	77.58e3	85.77e3
CPLP	309.4e3	309.4e3	309.4e3	309.4e3	309.4e3	309.4e3
CPLR	250.7e3	255.e3	259.3e3	263.8e3	268.2e3	272.8e3
YEAR	1996.	1997.	1998.	1999.	2000.	2001.

Table C-7--continued

YEAR	2002.	2003.	2004.	2005.
R1	9552.3	9715.7	9880.9	10.05e3
R2	4005.	4005.	4005.	4005.
R3	665.73	665.73	665.73	665.73
R4	589.18	589.18	589.18	589.18
R5	1090.2	1090.2	1090.2	1090.2
R6	447.07	447.07	447.07	447.07
R7	431.9	431.9	431.9	431.9
R8	6009.6	6111.8	6215.1	6319.6
R9	1911.4	1943.	1974.9	2007.2
R10	95.61e3	97.25e3	98.9e3	100.6e3
R11	89.08e3	90.59e3	92.13e3	93.67e3
R12	1170.3	1170.3	1170.3	1170.3
R13	1359.8	1359.8	1359.8	1359.8
R14	134.9e3	137.2e3	139.4e3	141.7e3
R15	50.8e3	51.69e3	52.6e3	53.52e3
R16	89.08e3	90.59e3	92.13e3	93.67e3
R17	1170.3	1170.3	1170.3	1170.3
R18	1359.8	1359.8	1359.8	1359.8
R19	134.9e3	137.2e3	139.4e3	141.7e3
R20	50.8e3	51.69e3	52.6e3	53.52e3
R21	1367.4	1390.8	1414.4	1438.4
R22	2914.8	2914.8	2914.8	2914.8
R23	218.67	218.67	218.67	218.67
R24	157.28	157.28	157.28	157.28
R25	2678.7	2723.	2767.8	2813.
R26	1005.	1022.6	1040.6	1058.8
FLAP	1334.e3	1319.e3	1304.e3	1289.e3
HLAP	96.98e3	98.64e3	100.3e3	102.e3
VTJP	8010.	8010.	8010.	8010.
NJAP	1836.	1836.	1836.	1836.
JAPP	1949.	1949.	1949.	1949.
IOJT	95.09e3	96.71e3	98.34e3	100.e3
JMLP	139.5e3	141.8e3	144.2e3	146.5e3
FMLP	51.8e3	52.71e3	53.64e3	54.58e3
ILDP	94.05e3	102.4e3	110.9e3	119.4e3
CPLP	309.4e3	309.4e3	309.4e3	309.4e3
CPLR	277.3e3	282.e3	286.7e3	291.4e3
YEAR	2002.	2003.	2004.	2005.

INITIAL LEVEL EQUATIONS

The initial labor pool values are based upon a 20% union vs. 80% non-union labor market distribution (Tomsho, 1993).

FLAP Florida Labor Pool

This value is set at 1,500,000 individuals, a number sufficient to meet the demands for labor during the calculation period of 15 years. Labor supply and demand theory states that if there is an insufficient supply of individuals to meet the labor demands of the industry, then wages will increase until the supply of labor meets the demand for labor.

HLAP Helper Labor Pool

This value is the calculated number of construction Helpers using Levitt's article *Union Versus Nonunion Construction in the U.S.* (1979) and the BLMI data to quantify the current levels of construction craft employment. The initial value is 67,773 (30% of the current employment level) plus the initial Journeyman demand (4,873) plus the difference between the required number of apprentices and the actual number of apprentices (4,421) plus the initial number of helper separations (1,106) plus 1/2 year growth (332).

VTJP Vo-tech Job Preparation Programs

This value is the average number of individuals annually completing construction related job preparation in vocational and technical education institutions in Florida, per the F-DOE data. The initial value is 8,010 individuals. The calculated dropout rate in job prep programs is approximately 2,915 individuals annually.

NJAP Nonjoint Apprenticeship Programs

This value is the number of individuals currently enrolled in nonjoint apprenticeship training programs in Florida, per the F-BAT data. The initial value is the current enrollment (1,617) plus the initial number of dropouts (219) that was calculated per the survey data.

JAPP Joint Apprenticeship Programs

This value is the number of individuals currently enrolled in joint apprenticeship training programs in Florida, per the F-BAT data. The initial value is

the current enrollment (1,792) plus the initial number of dropouts (157) that was calculated per the survey data.

IOJT Informal On-the-Job Training

This value is the number of semiskilled individuals in the construction work force. The initial value is the calculated number of helpers (67,773) plus the calculated number of hands transferring to journeyman status (4,873) plus the difference in the required number of apprentices minus the actual number of apprentices (4,421).

JMLP Journeymen Labor Pool

This value is the calculated number of journeymen using Levitt's article *Union Versus Nonunion Construction in the U.S.* (1979) and the BLMI data to quantify the current level of construction craft employment. The initial value is 113,807 individuals, the actual number of journeymen (110,059) plus the initial departure level (3,748). The required number of journeymen is 48.7% of the current employment level.

FMLP Foremen Labor Pool

This value is the calculated number of foremen using Levitt's article *Union Versus Nonunion Construction in the U.S.* (1979) and the BLMI data to quantify the current levels of construction employment. The initial value is 41,943 individuals, the actual number of foremen (41,127) plus the initial departure level (816). The required number of foremen is 18.2% of the current employment level.

CPLP Construction Project Labor Pool

This value is the BLMI estimate of the number of individuals employed in the construction industry for the year 1990. The 1990 employment level was estimated at 225,911 individuals and the average annual growth rate of 4,114 individuals and the average annual separations of 4,481 individuals for a yearly opening for 8,595 individuals.

RATE EQUATIONS

This Construction Labor Training Model utilizes data from the BLMI, the F-DOE, and the F-BAT.

Note: The BLMI Occupational Employment Projections calculate the base 1990 employment level for Construction Trades (Occupation Code #87000000) of 225,911 individuals and a 2005 projected employment level of 287,621 individuals. The simple %Δ is ((287,621 - 225,911) ÷ 15) ÷ 287,621 = 1.82%; however, for calculating growth levels the compound %Δ must be used or the numbers will not work out. The formula for compound growth is $287{,}621 = 225{,}911(1 + k)^{15}$ where k = compound %Δ. Solving this equation yields the compound %Δ of 1.62%.

Rate Equation #1

This equation is the number of people entering the helper labor pool (calculated data based upon manpower demand). This model also assumes no increase in formal craft training, therefore all industry growth must initiate in the Helper Labor Pool. The calculated, initial, number of helper separations is 1,106 individuals. The calculated annual growth in the Helper Labor Pool is 2,843 individuals. The calculated, initial, difference between the required number of apprentices and the actual number in formal apprenticeship programs is 4,421 individuals.

Rate Equation #2

This equation is the number of individuals entering the publicly funded vocational and technical education job preparation programs located in Florida (per F-DOE data). The initial requirement is 4,005 individuals annually, 1,090 annual graduations and 2,915 annual dropouts.

Rate Equation #3

This equation is the number of individuals entering the nonjoint craft apprenticeship programs during the calculation period. The initial level was developed from the F-BAT data. As of December 1992, there were 1,617 individuals in formal nonjoint construction apprenticeship programs in Florida. This calculates out to an annual level of 447 completions in nonjoint apprenticeship programs.

Rate Equation #4

This equation is the number of individuals entering the joint craft apprenticeship programs during the calculation period. The initial level was developed

from the F-BAT data. As of December 1992, there were 1,792 individuals in formal joint construction craft apprenticeship programs in Florida. This calculates out to an annual level of 432 completions in Joint apprenticeship programs. It is of interest to note that unionized construction holds approximately 20% of the construction market, yet have 10.8% more apprentices in training programs than do non-union contractors. Nonunion contractors would need to have approximately 7,168 individuals in apprenticeship programs to offer the same level of training, based upon market share, as union contractors.

Rate Equation #5

This equation is the annual number of individuals graduating from publicly funded vocational and technical education job preparation programs in Florida. This information was developed from F-DOE data and the survey data on dropout rates. The annual number of job prep graduates is 1,090 individuals.

Rate Equation #6

This equation is the annual number of nonjoint apprenticeship completions supplying the demand for journeyman level craft workers and the annual dropout rate for nonjoint apprentices developed from the survey data. The calculated, initial, demand for skilled craft workers (journeyman & foreman) is 5,742 individuals per year. Nonjoint apprenticeship programs supply approximately 447 individuals per year to meet this demand (7.8% of demand).

Rate Equation #7

This equation is the annual number of joint apprenticeship completions supplying the annual demand for journeyman level craft workers and the calculated annual Joint apprentice dropout rate per the survey data. The calculated, initial, demand for skilled craft workers (journeyman & foreman) is 5,742 individuals per year. Joint apprenticeship programs supply approximately 432 individuals per year to meet this demand (7.5% of demand).

Rate Equation #8

This equation is the number of people moving from the helper labor pool and from vo-tech job prep programs, receiving informal on-the-job training, and eventually spending enough time in the industry to achieve "informally trained journeyman" status. This number is calculated to be 4,783 individuals initially (5,742 annual requirement - 879 annual, formal, apprenticeship completions).

Rate Equation #9

This equation is the number of journeymen who supply the annual demand for foremen, 1,564 individuals initially.

Rate Equation #10

This equation is the annual demand for unskilled individuals on the job site. It is assumed that unskilled individuals must receive some form of on-the-job training in order to perform work tasks on the construction job site.

Rate Equation #11

This equation is the annual demand for semiskilled individuals on the job site. This number is the initial, annual, requirement for the number of helpers plus the difference between the calculated demand for apprentices and the actual supply of apprentices plus the calculated helper growth.

Rate Equation #12

This equation is the number of nonjoint apprentices continuing in the training programs (total - completions, or 1,617 - 447 = 1,170 individuals).

Rate Equation #13

This equation is the number of Joint apprentices continuing in the training programs (total - completions, or 1,792 - 432 = 1,360 individuals).

Rate Equation #14

This equation is the annual demand for journeymen on the job site.

Rate Equation #15

This equation is the annual demand for foremen on the job site.

Rate Equation #16

This equation is returning the informally trained craft workers to the helper labor pool at the end of the calculation period each year.

Rate Equation #17

This equation is returning the nonjoint apprentices to the program at the end of the calculation period each year.

Rate Equation #18

This equation is returning the joint apprentices to the program at the end of the calculation period each year.

Rate Equation #19

This equation is returning the journeymen to the Journeyman Labor Pool at the end of the calculation period each year.

Rate Equation #20

This equation is returning the foremen to the Foremen Labor Pool at the end of the calculation period each year.

Rate Equation #21

This equation is the number of individuals who drop out of the Helper Labor Pool during the calculation period.

Rate Equation #22

This equation is the number of individuals who drop out of publicly funded vocational and technical education job preparation programs prior to completion. It should be noted that dropouts in this category are not considered part of the BLMI yearly separation calculation since these individuals do not enter the industry until graduation from the program. Also, the supply of individuals graduating from HVAC job prep programs exceeds the estimated number of annual openings available to these individuals by 257 openings (supply is greater than demand). Therefore, the estimated demand for HVAC mechanics is utilized in the model, not the estimate supply.

Rate Equation #23

This equation is the number of individuals who leave the nonjoint apprenticeship training programs prior to completion.

Rate Equation #24

This equation is the number of individuals who drop out of the joint apprenticeship training programs prior to completion.

Rate Equation #25

This equation is the number of journeymen who annually leave the industry.

Rate Equation #26

This equation is the number of foremen who annually leave the industry.

Auxiliary Equation CPLR and #A27

This equation is the construction industry demand for labor during the calculation period. It is used to verify that the calculated growth in the model equals the BLMI calculated labor requirements at the end of model time period (year 2005).

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BIOGRAPHICAL SKETCH

Tom George began working in the construction industry in 1969. In 1970 he began his plumbing apprenticeship and passed his journeyman's licensing exam in 1976.

In January 1977, he was admitted into the construction management program at the University of Nebraska. He graduated with a Bachelor of Science degree in December 1981.

During the summers of 1978 through 1981, and upon graduation, he worked for Peter Kiewit Sons' Company in Omaha, Nebraska; Alameda, California; and Prudhoe Bay, Alaska. This work consisted of modular oil processing facilities for the oil fields on Alaska's northern coast. He rotated through the estimating, scheduling, field engineering and cost engineering disciplines as the need for his professional development dictated. His final assignments for Kiewit included craft superintendent and estimate sponsor for $100 million construction projects.

Mr. George was admitted to the Master of Business Administration program at the University of Nebraska in 1986. He received his MBA degree with an emphasis in finance in May 1987.

Prior to admission into the University of Florida College of Architecture doctoral program in August 1991, he was the site project manager (1987-1989) for a multimillion-dollar-fast-track processing plant addition for the Dial Corporation in

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Paul Oppenheim

Paul Oppenheim, Chairman
Associate Professor of Building Construction

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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